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EXPANSION AND EXPORT.

The result of the general election held in this country last week, in its emphatic endorsement of the policy of the present administration and its condemnation of unsound financial policies, was the one thing needful to make the success of our export trade a certainty. Even under the adverse conditions which accompany political discussion we had begun to build up an export trade of large volume but of infinitely larger promise. The impetus given to American export business by the results following the Spanish War, and its accompanying demonstration of the superb effectiveness of our navy and army, while in itself great, must be less than that which will result from the clearing of the political atmosphere and the endorsement of an administration that has given us both prestige and prosperity. For these reasons we may look ahead confidently to a magnificent future for our export trade and to the building up of a commerce that will be second to none in the world.

While most Americans know and realize that in many departments of industrial activity we lead the world, and while it is universally conceded that we are a nation of inventors and mechanics, the fact that we are the largest civilized nation in the world has not generally been understood. With their population of more than seventy-six million of intelligent and educated citizens, the United States may well claim to be the largest national unit in the world, in so far as all that concerns progress and civilization is regarded. Russia, with its enormous area and swarming population, must be considered inferior to us because of the inferior value of the unit of population; the British and German empires come next in order, with France as a poor fourth. Taking this indisputable fact in connection with our establishment at the gateway of the East in the Philippines and the amazing resources possessed by our country, both in agriculture, in minerals, in forests and in climate, it is not difficult to perceive that more and more we must make our impress upon the progress of the world and that the coming century will see us far in the lead in industrial and material prosperity. This nation has multiplied its population thirty-one times in the last century; its export commerce in the last three or four years has much more than equaled that of all its previous history. With internal dissension and dissatisfaction stilled and with a policy regarding international relations that commands respect abroad and support at home its destiny is plain. The opportunity confronts us and it is not to be supposed that we will allow it to pass, or that the electrical industry—the most alert and advanced of all our modern activities—will fail to seize as its own the broader field that is now rapidly opening before it.

ELECTRIC TRACTION IN THE NEW YORK SUBWAY.

In various streets and public squares in New York city the appearance of hoisting engines and transporting systems and the upturning of the earth give evidence that, at last, the great work of the rapid transit subway has been begun. It is expected that the subway will be completed in about five years and ready for the installation of its electrical train equipment at that time.

It is interesting to look ahead and conceive what may be the character of the equipment that will then be used. The art of electric railroading is by no means standing still, and it seems rather more than likely that, in five years, it will have made such important advances that a system entirely different from those now in use will be installed in the tunnel. One naturally looks ahead to the time when this work will be begun and wonders what the bearing of the numerous experiments with polyphase traction now being made will be upon the contemplated installation. By that time, unless some difficulty which is now unforeseen, is encountered, there seems little doubt that a perfected system using alternating currents throughout will have been devised and sufficiently tested in practice to make its installation advisable if not imperative. Whatever the nature of the system used may be, the contemplated railway is far too large to be operated from a single centre of distribution by direct current at a moderate voltage; it will most unquestionably require

sub-stations of some character. Whether these will be of the present type and contain transformers for reducing the high-tension currents generated at a central plant and rotary converters for the translation of these into direct current, or whether the sub-stations will consist simply of transformers requiring no attendance and having no moving parts, is the question that remains for solution. It is always dangerous to prophecy too far ahead, but it may be said that the whole tendency of electrical engineering to-day looks toward a polyphase system of this character as the ideal to be attained in such large installations in the future. It is to be assumed that the highest intelligence will be brought to bear upon this fascinating problem and that the result which will be reached will be creditable. At the same time, looking ahead from the point of view of present knowledge and present progress, one is almost irresistibly led to the belief that the installation will be on the polyphase system throughout.

CONCERNING AUTOMOBILE DESIGN.

For the past week New York has been the scene of a show of automobile vehicles which may truly be said to be unique, in that for the first time in this country there was gathered together in it a collection of self-propelling vehicles of all the prominent types and of all classes of design. To the visitor this show exhibited several points of remarkable interest; among them that which naturally flows from an exhibition and comparison of the different types of automobile mechanisms in operation, but more especially from an observation of the design of automobile vehicles with reference to their use, whether for pleasure or business.

Certainly the most striking fact in automobile designs as they are exhibited is the rigid adherence of makers of such vehicles to shapes and structures already popular in horse-drawn vehicles. It seems as if designers, while permitting their imaginations full play in planning the mechanical equipment of such vehicles, have feared to wander far from the lines which the carriage-builder's art has rigidly imposed upon the structure of wheel vehicles. There seems absolutely no reasonable excuse for this adherence to precedent. It is as if the modern steamship should still have the high forecastle and the towering poop decks of the caravels of Columbus.

It has been established in architecture that the truest and best design is that which least conceals the structural elements entering into it. Apparently no builder of automobiles has attempted to make such a vehicle express the essential fact of its design—which is that it is an independent structure moving itself by a power contained within it. Seemingly no one has designed a vehicle with careful reference to the mechanics governing the movement of rolling bodies upon an uneven surface. For example, in nearly all modern automobiles the wheel base is too short and the centre of gravity is too high; the body of the vehicle is lifted up clear above the axles and set at such a height above the road as to necessitate one or two steps to enable its passengers to board it. In this body is carried a considerable weight, bringing the centre of gravity of the whole vehicle often above the hubs of the wheels and inviting the capsizing of the machine whenever it rounds a corner or runs over a slanted bit of roadway. Seeing that the wheels move independently upon their hubs and that there is no necessity for solid axles in automobile design, this feature seems absolutely unnecessary and even ridiculous. The large wheels generally adopted are, of course, an excellent feature, as they reduce the shock caused by running over small obstructions.

Another peculiarly noticeable feature of the vehicles recently on exhibition is the silence and smoothness of the electric vehicles as compared with other types of automobile. The gasoline machines that have been running around the track at Madison Square Garden have left upon the spectators an indelible impression on account of their racketing noise and the odor with which they charged the air, even in that vast enclosure. The steam machines are admirable so far as smoothness of running and ease of manipulation goes, but they also follow closely the familiar lines and look like horse vehicles on a rampage. Taken altogether, the strongest impression that is left by the show is the unsightliness of automobile lines. The machines were beautifully finished and tricked out with every grace of shining metal and mirror-like varnish, but they looked distressingly like a vast collection of ordinary carriages drawn by ghostly and invisible horses.

THE TELEPHONE SITUATION.

As time goes on the telephone situation in the United States becomes more and more interesting, especially as it refers to the American Telephone and Telegraph Company, which recently absorbed the American Bell Telephone Company. In our opinion the factors of chief importance demanding consideration are the legal, the financial and the operative or practical side of the company's work. During the administration of the late Mr. John E. Hudson, and of nearly all his predecessors in the presidency of this great enterprise, it has appeared that the legal issues growing out of important patent litigation were paramount. Now that many of the patents covering the fundamental elements of the art of telephony have expired this situation is somewhat changed and it seems likely that the financial and operative details of the company's work will be of chief importance hereafter. If the stockholders conclude that the large financial operations demanded by the extension and furtherance of the work of the corporation compel the direct attention of a financier of ability, no doubt the new president will be selected from among the ranks of New York or New England bankers and financiers. If, on the other hand, it appears that the great growth now in evidence in the telephone industry, and now, more than ever before, sure to continue, demands as the executive head of the corporation a practical and experienced telephone manager, it is likely that little difficulty will be found in securing him among the many able men identified in an executive capacity with practical telephone work.

The subject of telephone charges is one of the greatest importance and its discussion is even more valuable to telephone men than was that of the proper rates of charge for electricity supply to central sta-

tion men. In this issue Colonel C. E. McCluer, whose experience as a telephone man in both the Bell and independent companies extends over the entire history of telephone development, begins a highly interesting discussion of the subject which will doubtless commend itself to readers interested in the business management of telephone exchanges. He ardently advocates the measured-service system as contrasted to the flat-rate method of charging, and makes some practical suggestions which can not fail to meet with approval. It is perfectly evident that the flat-rate system of charging is inequitable, and that in most places the exchange is burdened with a large amount of work arising from the use of telephones by non-subscribers. Among the several methods for arriving at a fair rate of charge, and at the same time shutting off the non-paying person from using the telephone service, that Colonel McCluer suggests, some one must be applicable in nearly every situation. Whether the coin or token method will work better in practice than the registering of calls at the exchange is something that can be determined only by the test of time and experience; either one, however, is certainly preferable to the method which permits one man to use his telephone ten times as much as another and yet charges both the same price for service. The necessarily high charges that must be made to maintain the average income of a telephone exchange under these circumstances have been the largest obstacle in the way of a more widespread extension of telephone service.

Why is it that some people will go to considerable expense in renting space at expositions and trade shows, and to still further expense in moving in and installing exhibits of valuable articles so that they may be inspected by possible intending purchasers, and then leave the exhibit in charge of some ignorant boy who can not answer the simplest question concerning it? At some of the exhibitions recently held in New York city, this practice has been very much in evidence, greatly to the annoyance of visitors and certainly to the considerable loss of exhibitors.

THE VALUE OF WATERFALLS.

Two circumstances that have attended engineering development in the last decade have brought prominently forward the importance and value of waterfalls, when these are situated in hospitable climates and near civilized centres. One of these is the rapidly diminishing supply of coal and the other is the recent development of electrical engineering, making the transmission of power and its distribution in various forms practical and assisting enormously in the development of the latent power of streams and cascades. Nothing has added more to the value of waterfalls than the ability of electrical engineers to transform their power and transmit it or distribute it in useful form. There has been in the last five years a tremendous development of water power for electrical plants on this account and the work is going on at an increasing ratio, not only in the United States, but in practically all the countries of the world.

While it has been known ever since the water-wheel was contrived that a waterfall was actually valuable as a source of power and could be used to replace the labor of men or beasts, the enormous value of great waterfalls has only of late been realized. It is doubtful if it is even now entirely realized because the immediate results that may be obtained from developing the power of a stream are by no means all, or even the most important part, of the valuable accomplishment embraced in such an enterprise. Take the case of a waterfall in a comparatively sparsely-inhabited section of the country, and imagine a development of, say, fifty thousand horse-power to be made. The immediate result will be a profit to the promoters of the enterprise that will pay a good dividend upon a very large amount of money; but this is by no means all. The actual tangible value of every acre of territory within transmission limits of the plant, that is, within the region where power can be sold at a less price than it costs to generate it otherwise, will be enhanced. The establishment of factories to use the power thus developed will bring population to the neighborhood and thus add another increment of value to real estate and other elements of taxable valuation to the community. The manufacturers themselves will work upon raw materials, producing in them greater values, and thus every element that goes to the creation of wealth will be manifested. To reduce it to figures, such power developments as those at Niagara Falls or Massena, N. Y., add actually to the wealth of the community a sum equivalent to several hundred dollars for every horse-power developed. Assuming that four million horse-power can be developed at Niagara Falls by the total utilization of that mighty cataract, the profit from such an enterprise should certainly approximate twenty million dollars a year, which is interest at four per cent on the almost incredible sum of five hundred million dollars. But, enormous as it is, this would represent only a small portion of the wealth that would be represented by such a development, because at least as much more could be expected as an increment in the value of real estate within transmission radius and every factory and industry that was established in this region would also represent increased values. It might be said, therefore, that Niagara is worth more than a billion dollars as a power producer. Whether or not it is worth as much as this as a spectacle is a question that is beyond our province to discuss.

On another page will be found some interesting descriptions of French and German polyphase generators on exhibition at Paris. These machines possess several points of novelty, and their great size, taken together with the peculiarities of their construction, demands for them more than passing consideration. The French machine illustrated and described is not so marked in its features of novelty as that exhibited by the German firm, but seems to be simply a well-designed and well-constructed machine of remarkable efficiency. The German dynamo, with its peculiar ability to give currents of various kinds simultaneously, is, however, a somewhat radical departure. One may be pardoned for reserving opinion as to its value until it has been tested by practical experience extending over a long period.

THE THEORY OF ALTERNATING DYNAMO-ELECTRIC MECHANISMS—III.

BY W. ELWELL GOLDSBOROUGH.

Similarly, Fig. 8 shows the effect of combining the same two waves with a semi-wave-length of phase displacement; namely, the waves starting from the zero line coincidentally in opposite directions, or the harmonic being displaced half a wave length. The resultant wave is also symmetrical but very much peaked.

Since, however, flat waves and peaked waves are the commonest deviations in form of the electro-motive force waves from the sinusoidal, Figs. 7 and 8 show that a prominent third harmonic is to be expected in such cases, *i. e.*, a third harmonic of considerable amplitude is probably present. Practically harmonics above the fifth are usually not prominent in alternating-current waves, although cases occur in which very much higher harmonics have a distinct influence.[1]

Fig. 9 shows a current wave taken from Professor Ryan's paper on transformers, read before the American Institute of Electrical Engineers, in January, 1890. It has been analyzed into its component harmonics, shown by the dotted curves, and is expressed by this equation:

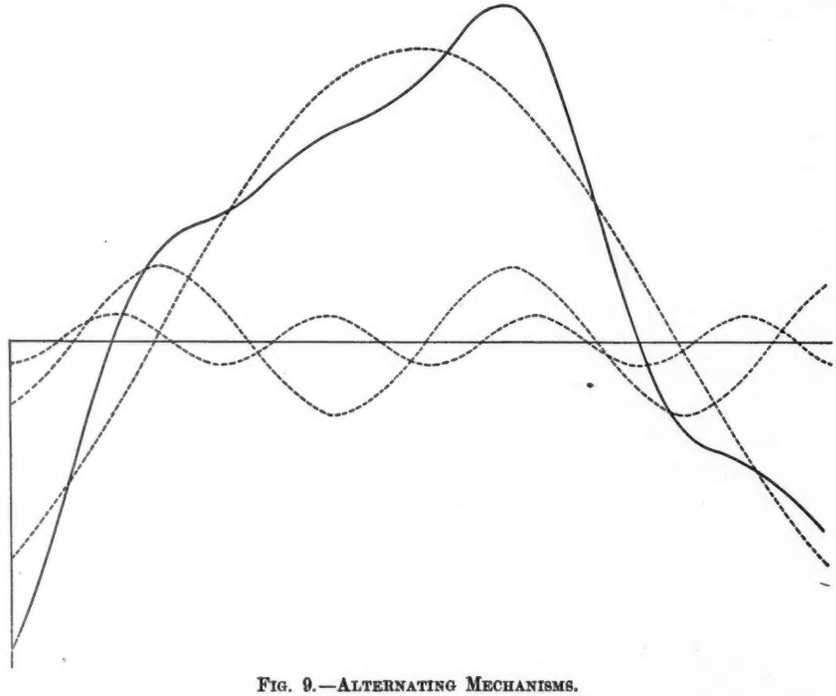


FIG. 9.—ALTERNATING MECHANISMS.

$$i = .1963 \sin(\omega t - 49°20') + .0482 \sin(3\omega t - 76°50') \times .01627 \sin(5\omega t - 90°). \quad (27)$$

This curve is obviously a "single-valued function," that is to say, corresponding to a given instant of time the current can only have one value. The curve never cuts itself or doubles back. A "multiple-valued function" is one that may have more than one value at any point of time; it either cuts itself or doubles back.

Jean Baptiste Joseph Fourier first enunciated the remarkable mathematical theorem generally stated as follows:

Any single-valued periodic function can be expressed analytically as the sum of a series of terms, the first of which is an arbitrary constant, and each of the following terms the sine or cosine of an angle multiplied by a constant.

The most remarkable part of Fourier's method[2] is its power to represent in this form of equation even a curve made up of straight lines. In Fig. 13 is shown a

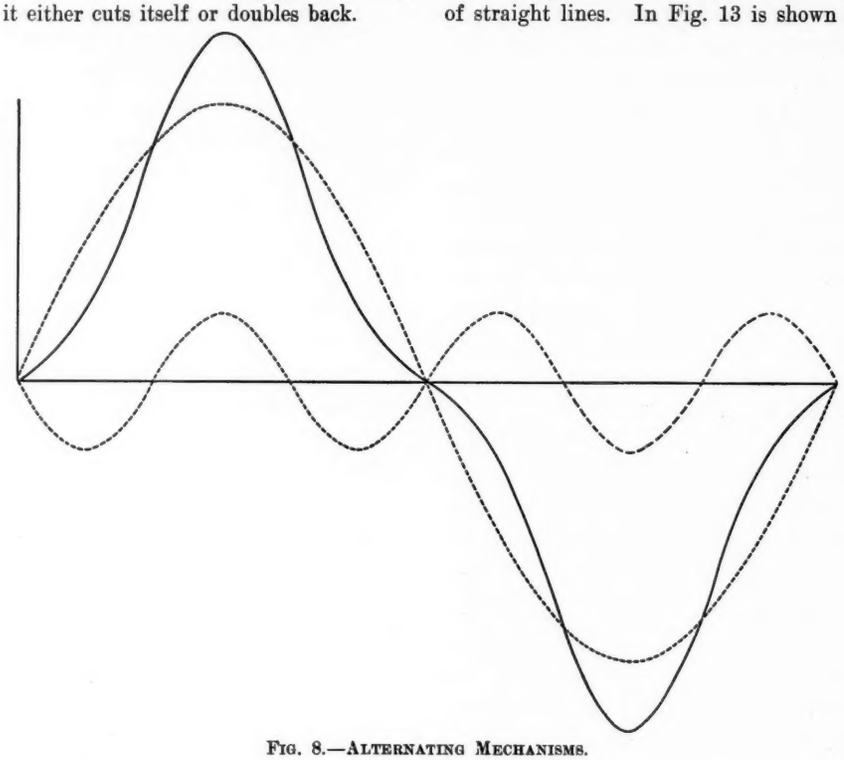


FIG. 8.—ALTERNATING MECHANISMS.

curve made up of lines inclined at angles of 60 degrees, like the teeth of a saw, the length of each line being 2π units of length. It can be shown[3] that the equation to the broken line in Fig. 13 is the series,

$$y = \frac{4}{\pi}\left(\sin x - \frac{1}{9}\sin 3x + \frac{1}{25}\sin 5x - \text{etc.}\right) \quad (28)$$

or is an expression formed of the sum of a series of terms, each of which is the sine of an angle multiplied by a constant term.

Example No. 1: Graphically represent the function expressed by the equation

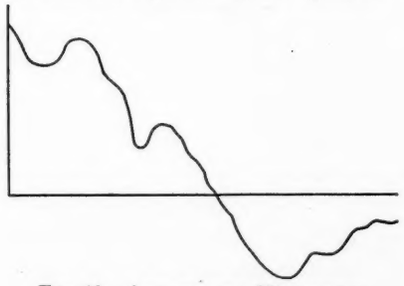


FIG. 10.—ALTERNATING MECHANISMS.

$$e = f(t) = 20 \sin \omega t + 15 \sin(\omega t + 45°) + 10 \sin(\omega t + 90°) \text{ when } N = 50. \quad (29)$$

In Fig. 14 (OA) represents by its length the amplitude and by its position the

[1] Houston and Kennelly on "The Harmonics of Alternating Currents," the *Electrical World*, page 735, vol. xxiii.

[2] Byerly's Fourier's Series and Spherical Harmonics, page 40.

[3] Fleming's The Alternate Current Transformer, page 77, vol. i, and vol. ii, page 454.

value of (20 sin ωt) when $t = 0$. Its projection on (OY) is zero, and as it travels in a clockwise direction the harmonic curve that represents the variations in the projections of (OA) on (OY_1), with the time, will be just on the point of falling below the horizontal axis, as at

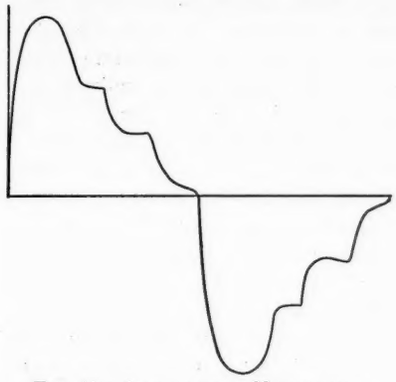


FIG. 11.—ALTERNATING MECHANISMS.

(O_1). (O_1P_1) is taken as the time of one-quarter of a revolution of (OA) about (O), and as N = 50 revolutions per second, when (A) reaches (Y), t will have increased from 0 to,

$1 \div (4 \times 50) = .005$ seconds, since

$T = \frac{1}{N} = .02$ secs, $= O_1S_1$,—see equa. 11,

and the value of the projection of (OA) on (OY_1) will be equal to the amplitude of the function (20 sin ωt), that is 20, as represented by (P_1p_1). When $t = .01$ secs. (OA) will have made half a revolution, and the curve will be crossing the (X) axis in a positive direction at (Q_1). When $t = .015$ secs. three-fourths of a revolution will have taken place, and the function will have increased to its positive maximum, as shown at (R_1r_1), and so on.

(OB), drawn 45° in advance of (OA), represents by its length the amplitude and by its position the value of sin ($\omega t + 45°$), when $t = 0$. The initial point of the curve showing the development of this function is at (O_2). (B) will reach the (Y) axis in the time of one-eighth

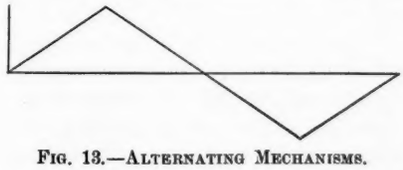


FIG. 13.—ALTERNATING MECHANISMS.

part of a revolution or when $t = .0025$ secs., and therefore the curve will reach its crest at p_2, since $O_1P_2 = T \div 8$; this function will be zero for the first time when (B) reaches $(X)_1$ or when $t = 5\ T \div 8 = .0075$ secs., as shown at (Q_2) where the curve $O_2p_2Q_2$ crosses (OX) in a positive direction.

(OC), drawn 90° in advance of (OA), represents by its length the amplitude and by its position the value of 10 sin ($\omega t + 90°$), when $t = 0$. Since at this instant sin ($\omega t + 90°$) = 1, and (OC) coincides with (OY_1), the curve representing this function starts from the point of its maximum negative displacement as shown at (O_3), and immediately commences to decrease as (C) moves on to (X_1). The

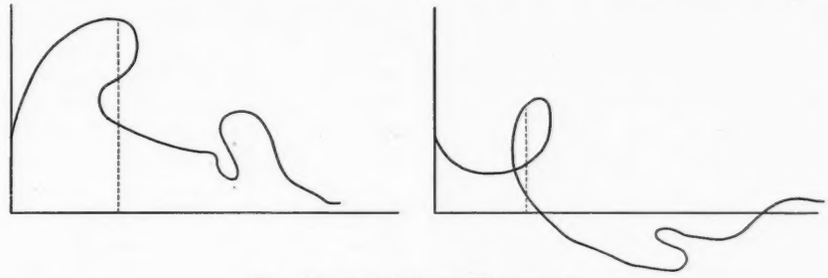


FIG. 12.—ALTERNATING MECHANISMS.

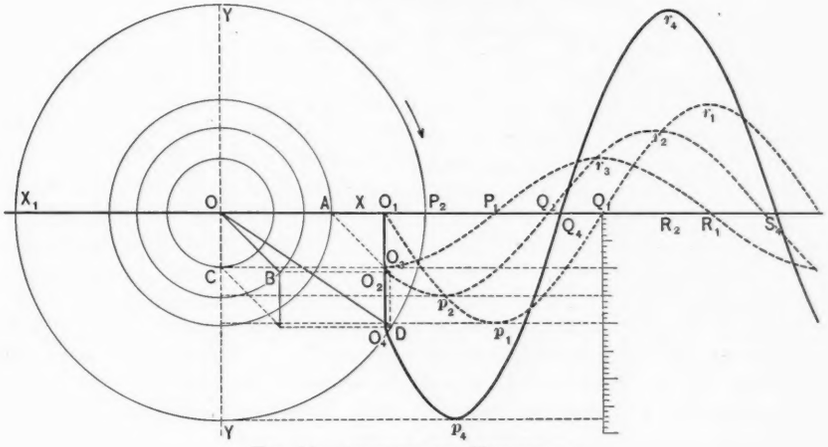


FIG. 14.—ALTERNATING MECHANISMS.

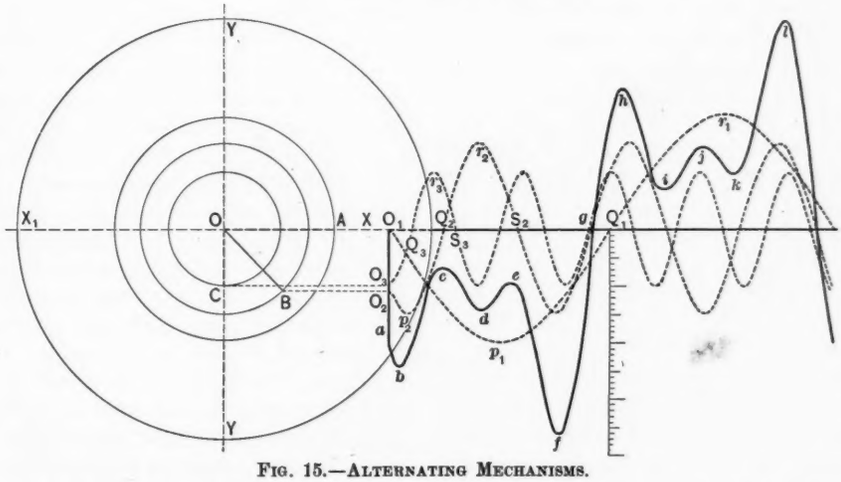


FIG. 15.—ALTERNATING MECHANISMS.

curve $O_3P_1r_3R_1$ shows the development of this function, which is always a + or — maximum when the curve $O_1p_1Q_1r_1$ is zero, and always zero when this function is a + or — maximum. Carefully note this peculiarity of two curves differing in phase by 90°.

If now we add the corresponding ordinates of the curves already plotted we will obtain the curve $O_4p_4Q_4r_4S_4$ as a resultant. This curve is a pure sine function, by the demonstration on page 479, and can be developed by the vector (OD), which is the vector sum of (OA), (OB), and (OC), and has the same angular velocity. It is 33° 53′ in advance of (OA) and has an amplitude of 37.5 units. In its position in the figure it represents the value of (e) in equation (29), when $t = 0$.

Example No. 2 graphically represents the function expressed by the equation,

$$e = f(t) = 20 \sin \omega t + 15 \sin (3\omega t + 45°) + 10 \sin (5\omega t + 90°) \qquad (30)$$

when N = 50.

Here (e) is a function of the time involving a number of sine functions which differ both in *period* and amplitude.

(20 sin ωt) is the fundamental and (OA) (Fig. 15) represents the value of this function when $t = 0$. (OA) therefore makes a revolution in .02 seconds or makes 50 revolutions per second.

15 sin (3 $\omega t + 45°$) is the third harmonic, its period is therefore one-third less than the fundamental or .0066 seconds; that is the vector (OB), which represents the value of 15 sin (3 $\omega t + 45°$) when $t = 0$, begins to revolve at a rate of 150 times per second or three times as fast as (OA) as soon as the vectors start.

10 sin (5 $\omega t + 45°$) is the fifth harmonic. Its period is one-fifth of .02 or .004 seconds, and the vector (OC) that represents its value when $t = 0$, revolves 250 times per second or five times as fast as (OA), as soon as the vectors start.

It will be seen that these vectors *start* from the same points as the corresponding vectors in Fig. 14, and that, although they have different speeds or angular velocities, they return to the same relative positions once every .02 seconds.

In Fig. 15 the curves representing these component functions have been plotted. The curve $O_1p_1Q_1r_1$ represents (20 sin ωt) and is the same as the curve $O_1p_1Q_1r_1$ of of Fig. 14. The curve $O_2p_2Q_2r_2$ represents 15 sin (3 $\omega t + 45°$); it is the same as the curve $O_2p_2Q_2r_2$ of Fig. 14 except that it has a period but one-third as great, *i. e.*, O_1Q_2 in Fig. 14 is three times as great as O_1Q_2, Fig. 15. The curve $O_3Q_3r_3S_3$ represents 10 sin (5 $\omega t + 90°$) it is the same curve as $O_3P_1r_3R_1$ of Fig. 14 except that its period is one-fifth as great.

Adding up the corresponding ordinates of the component curves the curve *abcdefghijkl* is obtained. It has the same period as the fundamental (since .02 is the least common multiple of .02, .0066 and .004) and is *not a harmonic function.*

New York Electrical Society.

The two hundred and ninth meeting of the society will be held at the College of the City of New York, Twenty-third street and Lexington avenue, on Friday, November 16, at 8 P. M. Mr. C. P. Steinmetz will lecture on "Alternating-Current Engineering." The subject will be treated from the practical standpoint, and the lecture will furnish a complete survey of the tendency of the time in the whole field of electric light, power and railway work. Mr. Steinmetz occupies a preeminent position in this important department of electrical work, and his utterances are received on both sides of the Atlantic with the utmost interest and attention. The lecture will be one of the most important ever delivered before the society.

HEATING VALUE OF EXHAUST STEAM AT ELECTRIC STATIONS.

BY ALTON D. ADAMS.

One pound of exhaust steam at atmospheric pressure, or 14.7 pounds per square inch, contains 966 units of latent heat. The temperature of steam at this pressure is 212 degrees Fahrenheit and when it is condensed to water of the same temperature the 966 heat units per pound are given up. Steam at 5.3 pounds gauge or 20 pounds per square inch absolute pressure, drops to 954 units of latent heat per pound, and at 10.3 pounds gauge, or 25 pounds absolute there is another drop of latent heat to 946 units per pound of steam. This small variation of two per cent in the latent heat of steam between gauge pressures of zero and 10.3 pounds per square inch may well be neglected in computations concerning steam heating, as the water of the condensed steam has a temperature of 228 degrees at 5.3 pounds and 240 degrees at 10.3 pounds pressure instead of only 212 degrees at atmospheric pressure. This hot water of condensation will tend to make up the small reduction of latent heat in steam at the higher pressures. Saturated steam of course has the same number of latent heat units per pound whether it comes from the boiler direct or by way of the engine exhaust. Hot water of condensation at the temperature of 212 degrees obviously can not give up its heat to radiators that are of equal or higher temperature, so long as the steam does not fall below atmospheric pressure. The practical measure of heat from exhaust steam in radiators is therefore the number of latent units per pound at atmospheric pressure—that is, 966. It may be considered that all steam condensed in the pipes as well as the radiators of a building contributes to the general warming effect. Where long lines of underground pipe must be laid between the point where steam is generated and the buildings to be heated, some steam must be condensed in these pipes and its energy lost. The amount of condensation that takes place in long lines of steam pipes underground depends on a number of factors that can not be discussed here. It may be said in general, however, that for pipes up to one-half mile in length, not more than one-fifth of the steam entering them should be wasted by local condensation. Each pound of exhaust steam sent into the system represents a delivery of 773 available heat units on the premises of the consumer, if 20 per cent is wasted. This heat can be readily utilized with the ordinary types of either steam or hot water radiators. In the steam radiators the exhaust will give practically the same results as steam from local boilers, while in radiators designed for hot water the heating effect would be greater with exhaust steam because of the higher average radiator temperature. Direct radiating surface usually gives off 1.5 to 2 heat units per hour for each degree Fahrenheit difference in temperature between the radiators and the surrounding air. A fair mean value may be taken at 1.75 heat units per hour from each square foot of radiating surface, per degree of temperature difference. On this basis one foot of radiating surface at 212 degrees Fahrenheit, in a room where the air is at 70 degrees, gives off 248 heat units per hour.

The latent heat in one pound of steam at atmospheric pressure, or 966 units, will thus supply 3.9 square feet of average heating surface per hour. In case of the 20 per cent loss in the pipes for steam distribution, one pound of exhaust sent into the heating system should supply 3.1 square feet of direct heating surface in the consumer's building.

So important are the effects of the proportions and construction of buildings on the heat that they require per unit of contained space that no accurate relation can be stated between the cubic feet of a building and the necessary square feet of heating surface. An approximate figure for ordinary business buildings is one square foot of direct radiating surface for each 70 cubic feet of space heated. With this average relation between radiator surfaces and interior spaces, the 3.1 square feet of direct radiation that one pound of steam, delivered to the distribution mains, was found to supply, will heat during one hour 217 cubic feet of building interiors. It should be held in mind that any system of heating can do no more than maintain such radiating surface as is provided at the maximum temperature and if sufficient heat is not then obtained, more radiating surface should be added. In general the radiating surface necessary for each building should be calculated from its form, exposure and materials of construction.

Heating from central stations must compete with that of stoves, furnaces and boilers on consumers' premises. The cost of heat locally developed is mainly composed of three classes of items, interest, depreciation and repairs on the equipment, the expense for labor and the outlay for fuel. In some cases the first two classes—that is, fixed charges on the plant and the labor of attention—are duly estimated when the value of heating from a public supply is considered. This is more apt

to be the case in large buildings where the services of an engineer can be saved, if the heat supply is drawn from a central station. In the smaller business buildings and in residences the first cost of local heating apparatus is small and the item of labor for attention not easily computed. A result is that the price that can be got for heating large buildings is more apt to include the savings in labor and fixed charges on local plants than is the case in small buildings and residences. As to the fuel cost of heat the large plant is usually at a decided advantage over the small one. Stoves, house furnaces and heating boilers often show an efficiency in operation as low as 25 per cent. As heating plants grow larger the efficiency usually rises and often reaches fifty per cent in a large steam system for a mercantile building. While the small plant is thus at a seeming advantage as to labor and fixed charges, it is at a disadvantage in the amount of fuel consumed per unit of heat delivered. Another factor that tends to hold up the cost of heat in small plants and residences is the quality of fuel that they must in general use. The largest buildings with their high chimneys and first-class steam plants can often burn comparatively cheap grades of soft coal, but most small heating plants are confined to anthracite coal that is decidedly more expensive.

The cheap fuel of the large heating plants and the low outlay for labor and fixed charges in small ones probably in some measure balance each other. For the smallest plants the items of labor and fixed charges must have some value and it seems conservative to estimate the average price that can be obtained for heat from central stations to the approximate cost of coal per unit of delivered heat in small plants. A fair figure for the entire energy of complete combustion of anthracite coal is 1,300 heat units per pound. An efficiency of 30 per cent is probably as much as can be safely assumed for the regular operation of heating boilers, furnaces and stoves in stores of moderate size and in dwellings. The product of these two factors shows that 3,900 heat units may be expected for warming in small buildings from each pound of anthracite coal burned. Taking the price of this coal at $5 per ton, it appears that this sum is the fuel cost of 7,800,000 available heat units. Reverting to the fact that 773 heat units can be delivered at the consumer's premises for each pound of steam sent into the distribution mains, it appears that 10,090 pounds of steam can produce the same effect when distributed from a central station for warming small buildings, as one ton of coal burned in local stoves and furnaces. Allowing only the item of fuel to count as the expense of these local fires, it appears that the selling price of 10,090 pounds of steam should at least equal that of one ton of anthracite coal, or, as assumed here, $5.

It is next important to inquire what relation exists between the electrical output of a central station and the amount of exhaust steam it may have to sell. As electric station outputs are usually measured and stated in kilowatt-hours it will be convenient to note the weight of exhaust steam that may be expected per electrical unit. In order to distribute its exhaust steam for heating, the engines at a central station will be operated non-condensing. A well-designed station, however, should have compound engines unless the exhaust steam from such engines is less than is required for the heating system. Assuming compound engines to be the rule, and making some allowance for the variable loads under which electric stations must operate, 27 pounds of exhaust steam per brake horse-power-hour transmitted to the dynamo shafts, is a conservative estimate.

A net average efficiency for the combined electrical equipment in a central station of 90 per cent is certainly as high as can be expected, when the losses in storage batteries, station transformers and other regulating or converting machinery. In addition to those of the main dynamos are considered. This efficiency of 90 per cent allows one electrical horse-power-hour to be sent out of the station for each 30 pounds of exhaust steam rejected by the engines. Remembering that the electrical horse-power is the equivalent of 746 watts, it appears that 40 pounds of exhaust steam are available for each kilowatt-hour of electrical output. As it was found that 10,090 pounds of steam from the central station would produce an equal warming effect in buildings with one ton of anthracite coal costing $5, 40 pounds of steam will replace coal to the value of 1.98 cents at the premises of consumers. In other words, if the exhaust steam at an electric station can all be sold for heating purposes at simply the average cost of the anthracite coal it will save in general heating, the station revenue from the sale of steam will amount to 1.98 cents for each kilowatt-hour of electrical output.

It frequently happens, however, that a part of the exhaust steam is required to heat the feed water. The amount of exhaust remaining for other purposes after the feed-water has been heated should therefore be noted. It may be said at the start that the heat of flue gases is sufficient to heat the feed water and it is usually best to warm the feed in this way where the exhaust steam can be sold. If feed water enters the heater at a temperature of 40 degrees Fahrenheit, and leaves the heater at a temperature of 212 degrees, corresponding to that of exhaust steam at atmospheric pressure, each pound of water absorbs 173 heat units from the steam. As each pound of steam condensed at atmospheric pressure gives up 966 heat units, only 18 per cent of the exhaust steam can be condensed to heat a quantity of feed water equal in weight to all of the exhaust steam, to a temperature of 212 degrees. Allowing a little more water to enter the heater than is rejected as exhaust steam by engines, it appears that only one-fifth of the exhaust can be condensed to heat feed water. Making this reduction from the 40 pounds of steam found to be rejected by the engines for each kilowatt-hour delivered from electric stations, there still remains 322 pounds of steam for general distribution with each kilowatt-hour of electrical output. This amount of steam has capacity to supply heat at the premises of consumers equal to that from anthracite coal costing 1.58 cents at $5 per ton.

From the foregoing it appears that the gross revenue of an electric station may be increased at least by that ratio which 1.58 cents bears to its average selling price per kilowatt-hour, provided all of the exhaust steam can be sold for heating purposes. As very little heat is required for general warming during one-half of each year, it seems quite certain that only a comparatively small part of the exhaust at central stations can be sold during the warm months. On the other hand, the demand for heat during the cold months is so great that it may well consume more steam than the exhaust of engines at electric stations can supply. Take for illustration the case of an electric station having the moderate out-put of 20,000 kilowatt-hours per day. It was found above that 32 pounds of exhaust steam might be expected to be available for general distribution, per kilowatt-hour of output, after the feed water had been heated. On this basis the 20,000 kilowatt-hours would mean the supply of 640,000 pounds of exhaust daily. It was found that one pound of steam delivered to the pipe system might be expected to heat 217 cubic feet of buildings during one hour. If the daily condensation of steam is equivalent to that during 12 hours at the maximum rate, as is indicated

by some extensive observations, each 217 cubic feet of building space requires 12 pounds of steam daily. The exhaust each day of 640,000 pounds of steam will therefore supply 11,573,333 cubic feet of building space. A building having a ground area of 100 by 100 feet and 50 feet high contains 500,000 cubic feet. Twenty-three such buildings could therefore be heated with the daily supply of 640,000 pounds of steam. If grouped in a single block these 23 buildings would occupy a space 500 feet by 500 feet. While city buildings leave spaces for alleys and streets nor are all of them 50 feet high, it is evident that those within a few hundred feet of a centrally located station might readily consume the 640,000 pounds of steam per day for their maximum heating requirements. In warmer weather the cubic spaces of buildings that any given amount of exhaust steam can supply would of course be increased and the necessary radius of distribution from a central station consequently extended.

As it appears that the spaces which require heat in city buildings are far in excess of the production of exhaust steam at electric stations, it remains to be seen whether it is practicable to apply the exhaust directly to heating purposes. It is, of course, understood that the consumer must have heat just when he wants it, without regard to the production of exhaust steam of stations. Now it happens that the maximum supply of exhaust steam occurs at quite a different time of day from that of the greatest requirement for heat in buildings. Stations for the public supply of light and power usually carry their heaviest loads during the period from 4 to 8 P. M., and these loads are often several times the average in amount. In the power stations of electric railways there are heavy outputs from 6 to 10 A. M., but the greatest loads are carried from 5 to 7 P. M. The maximum demands for steam heat take place usually between 6 A. M. and noon, so that the large outputs of exhaust steam that come late in the afternoon are not available for them. In this lack of coincidence as to time of maximum exhaust supplies and heating demands, and also in the great excess of the maximum over the minimum and average rates of the exhaust steam supplies, lies the greatest difficulty in their application to heating. In view of these facts, either one of three courses seem open to the electric station as to the distribution of exhaust for warming buildings. First may be considered a plan by which only so much space in buildings is heated as can be supplied at all times by the exhaust then being produced. Such a plan is better adapted for a street railway than for an electric light station, but in either a large part of the exhaust will not be available for the heating system.

The portion of the total amount of steam rejected by the station engines in any case, that can be condensed in the heating system, must depend on the distribution as to time of the engine loads. Stations with heavy day loads of stationary motors will be able to sell more of their exhaust steam for heating than stations that do mostly a lighting business, provided that all of the electric energy is distributed at the times it is generated. Where relatively large storage batteries are used at a station and can be charged at such times during the earlier half of the day as best suits the requirements of the heating system, a larger portion of the total exhaust steam can be sold than in stations with similar loads and no batteries.

Any heating system that distributes only exhaust steam from electric stations must generally be of only moderate extent, and must allow either a large portion of the total exhaust to go to waste in even the coldest weather or else some of the station engines must be operated condensing during the periods of greatest loads. Whether, or to what extent, such a system of heating by the partial use of exhaust steam from electric stations will pay must depend on the circumstances of each case. When the disadvantages due to the unequal distribution as to time of the exhaust steam production at electric stations is considered, it is natural to look for means by which the surplus heat of exhaust at any time can be stored, so as to be available at a subsequent time for general use. Such storage and future use of the surplus heat of exhaust during any period may be considered the second plan for the utilization of exhaust steam for general heating. The weight of one cubic foot of steam at 10.3 pounds gauge pressure is only .062 pound, so that the storage of the exhaust at a station of 1,000 kilowatts output, during a single hour, at 40 pounds of exhaust steam per kilowatt, would require 645,000 cubic feet of space, under the 10.3 pounds pressure. It is obvious at once that the great space required by steam, to say nothing of the losses of heat that would result, would make the storage of large quantities impracticable. The latent heat of steam may, however, be readily stored in water. Thus one pound of steam, that occupies 16 cubic feet at 10.3 pounds gauge pressure, contains 946 units of latent heat, which can be stored in 5.25 pounds of water heated from 32 to 212 degrees Fahrenheit. This weight of water at 212 degrees occupies about .09 cubic foot or .0056 of the space required by the steam at 10.3 pounds pressure, whose latent heat it stores. While it is thus easy to store the heat of exhaust steam in water, this heat can only be made to appear in steam, when wanted, by passing the water through a boiler, but this involves the application of 5.25 times as much heat as was extracted from the exhaust. Hot water may thus be a desirable means for the storage of heat from surplus exhaust, but steam must be delivered by the boilers to the heating system without passing through the engines, and the heating system extended beyond the capacity for the exhaust steam alone. An exception to this last statement should be made for the case where the feed water is heated by engine exhaust, and all of the water heated and stored in one part of the day can be used as boiler feed at other times. Instead of changing the heated and stored water to steam, it may be subsequently circulated through the pipe system instead of steam, provided that all of the distributed heat is sent from the station in hot water. This is the system of heating from central stations by hot water. Such a system offers advantages for the distribution at one time of heat obtained from exhaust steam at another, but its general merits can not be taken up here. A third method for the application of exhaust steam from an electric station to a general heating system, includes a required capacity so large as to consume at least all of the available exhaust at the time it is given off by the engines. Such a system must draw a part of its steam directly from the boilers. The engine exhaust will supply a varying amount of the total steam requirement from time to time, and the additional steam necessary must be taken from the boilers. Obvious advantages of this plan are that all of the available exhaust is sold, no storage of heat is necessary, and the heating system may be indefinitely extended without regard to the electrical output. A wise choice of one of these plans by electric stations will result in a very material addition to present revenues, from the heating value of exhaust steam.

A new power house is being built by the Union Street Railway Company, of New Bedford, Mass., to meet the increasing demands of their traffic. The new structure will be of brick and the light supplied mainly by skylights. It will have a capacity of 6,000 horse-power.

FRENCH AND GERMAN POLYPHASE GENERATING UNITS AT THE PARIS EXPOSITION.

THE LARGE MACHINES OF THE FIVES-LILLE COMPANY AND THE AUGSBURG-NUREMBURG COMPANY—DETAILS OF CONSTRUCTION AND OPERATION.

BY C. L. DURAND.

One of the largest generating sets in the French section is the 800-kilowatt alternator built by the Fives-Lille Company, coupled to a cross-compound engine of the horizontal type. The whole outfit, including the boilers, has been designed by the same firm. The appearance of the alternator, which is of the triphase internal field type, will be seen in the illustration. It is mounted upon the shaft of the engine between the two main bearings, and its field serves as the flywheel. The alternator has a normal capacity of 800 kilowatts for a power factor exceeding 0.7. The voltage at the terminals is 2,200 volts, and 210 amperes per phase are supplied, at a frequency of 50 cycles. The detail views show the general arrangement of the field and armature. The field poles, of which there are 76, are mounted upon the rim of the flywheel. In this machine the poles are built up of laminated iron, held together by seven rivets, and carrying, near the lower part, a steel piece of square section which receives the bolts which hold it to the flywheel, care being taken to provide a good magnetic joint. Owing to the width of the air gap, 0.28 inch, the pole piece may be taken out laterally without disturbing the rest of the machine in case of repairs, and to rewind a part of the armature it is only necessary to uncover a part of it by taking out several field coils. The polar projections serve to hold the field coils in place; the bobbins are of cast brass. The coils are wound with 135 turns of 0.188 inch wire (insulated, 0.208 inch), in five layers of 31 turns each. The 76 field coils are mounted in two groups of 38 in series, the two groups being connected in parallel, and excited by direct current at 220 volts, a two-ring collector with four brushes being used. The field resistance is 3.06 ohms measured hot, and the total weight of the flywheel and coils is about 35 tons.

The external armature ring is about 25 feet in diameter and 28 inches wide, and is made in four pieces with vertical and horizontal joints. In the interior of this ring casting is mounted the laminated ring for the winding, which has 20 inches interior diameter. The external casting is supported near the floor level by a flat projection on each side and also by two foundation plates in the pit, which are provided with raising and lowering screws to centre the machine. The section shows the manner in which the plates are bolted to the ring casting, being held on by a ring at the other side. The plates are 0.02 inch thick and insulated by thin paper of 0.012 inch. The slots on the inner surface are nearly closed, and contain micanite tubes for the winding; there are six slots per pole, or for the 76 poles, 456 in all. They measure 1.16 by 0.6 inches; the opening is only 0.12 inch wide. The armature carries 114 coils, or 38 per phase, each coil occupying four slots and containing five turns of four wires in parallel. The diameter of the armature wire is 0.16 inch bare, or 1.76 inches insulated. The resistance for each phase is 0.078 ohm; the loss in the armature winding is about 1.3 per cent of the total. The exterior diameter of the laminated ring is 21 feet 6.45 inches, and the radial thickness 9 inches, with a width of 10.8 inches. The total weight of the complete armature, not including foundation plates, is 33.5 tons.

The engine, of the cross-compound type, acts by two cranks placed at 90 degrees

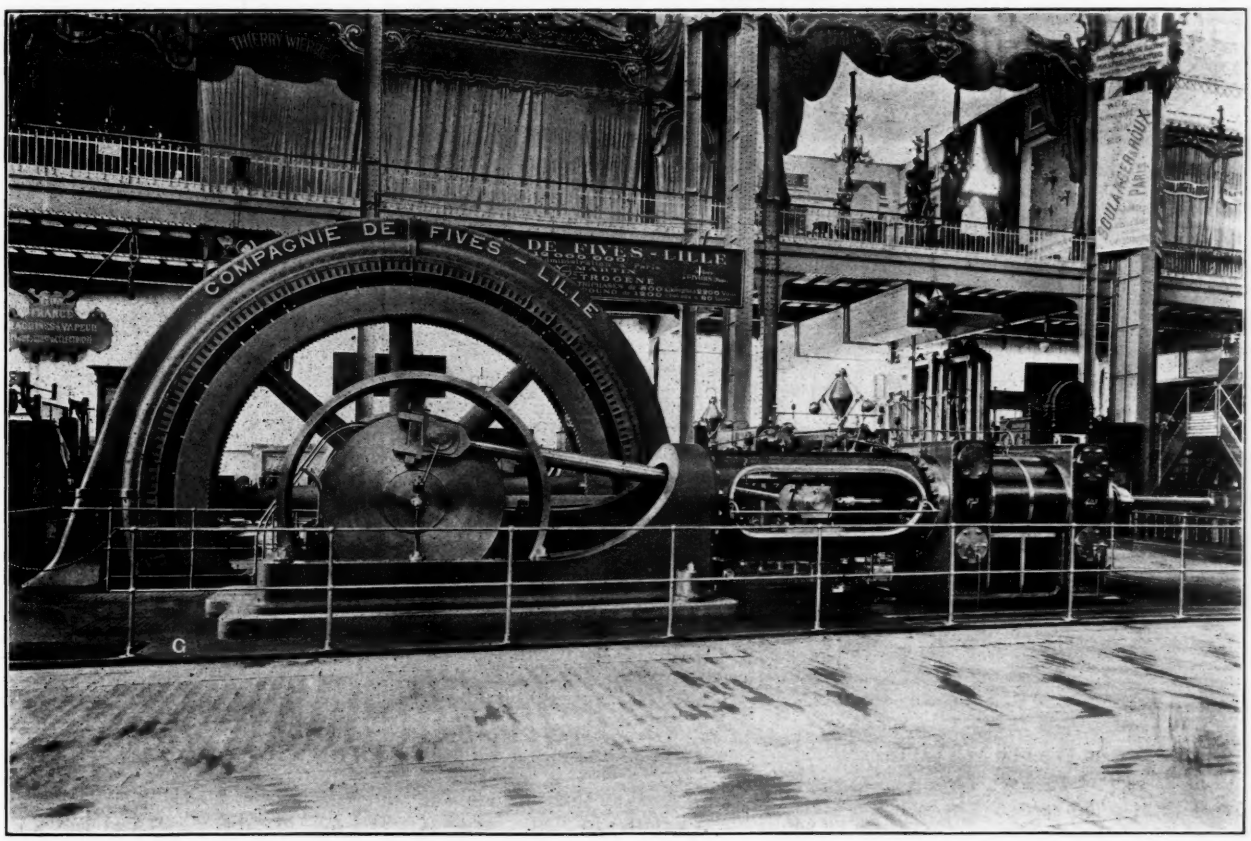


FIG. 1.—800-KILOWATT THREE-PHASE GENERATING SET EXHIBITED BY THE FIVES-LILLE COMPANY AT THE PARIS EXPOSITION.

apart upon the main shaft. The high-pressure cylinder has a diameter of 28 inches and the low-pressure cylinder of 51 inches, with a common stroke of 56 inches. The machine is built upon a solid bed-plate anchored to the foundation, which supports the bearings of the main shaft. The steam distribution is by the Corliss system. A centrifugal governor controls the admission to each of the cylinders. The admission may vary from 0 to 45 per cent in the high-pressure cylinder, and 12 to 60 per cent in the low pressure. The engine works very uniformly, and its coefficient of irregularity does not exceed

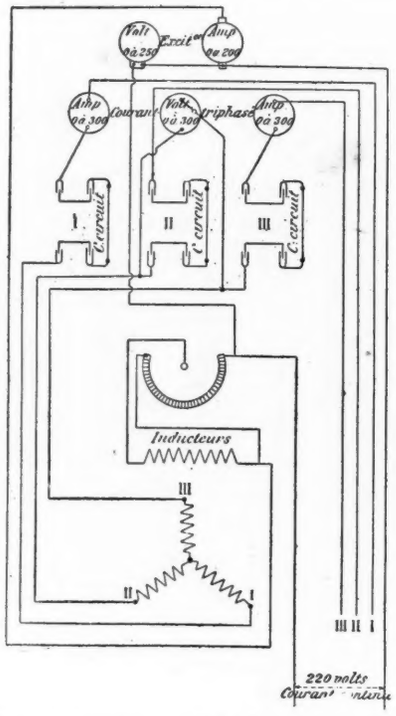


FIG. 2.—DIAGRAM OF FIVES-LILLE COMPANY'S SWITCHBOARD.

1-250 of the normal speed. The switch-board, which is mounted back of the machine, has a three-pole quick-break switch and three fusible cutouts. The arrangement of connections will be seen in the diagram. When the switches are open, the fuse blocks are isolated from the rest of the circuit and the fuses may be easily replaced in case of accident. A static voltmeter is used to read the voltage between two wires, and two 300-ampere ammeters are placed in series across two conductors. Above are placed the voltmeter and ammeter for the exciting circuit. The fuse blocks and rheostat coils are placed in the rear of the board. The performance of this machine in supplying light and power for the exposition circuits has been quite satisfactory; the electrical design is due to M. Desiré Korda, chief electrician of the company.

One of the largest generating groups at the exposition is found in the German section, and consists of a horizontal engine of the triple-expansion type, built by the Augsburg-Nuremburg Company, connected directly to a 3,000-kilowatt alternator of the Helios Company, of Cologne; the alternator is arranged to supply single-phase or triphase current, or both together. The engine of this group is the only horizontal engine in the German section, and is the most powerful of those used to supply light and power for the exposition. The alternator is of unusually large diameter and presents some interesting features. When working as a triphase generator it gives 3,000 kilowatts, or 2,000 kilowatts when giving monophase current; it can supply at the same time 1,200 kilowatts single-phase and 1,500 kilowatts triphase. For triphase currents its voltage may be 6,600, 3,300 or 2,200 volts. At the exposition it furnishes 2,200 volts single-phase current, working at 71.5 revolutions per minute and 50 periods. The alternator is formed of a flywheel, constituting the field, having 27 feet diameter mounted upon the engine shaft, and a fixed armature ring of 31 feet 6 inches exterior diameter. One of the most interesting points of this machine is that it furnishes monophase or triphase current separately or together; the constructors designed it so that it could not only fill the requirements of the exposition, but be used afterwards in a central station. This result has been obtained by combining two windings upon the inner surface of the armature crown, whose connections are made by the Scott method; the armature is made up of a main winding between whose coils is placed a secondary winding in which the voltage developed is $\sqrt{3/4}$ that of the main set. The coils of the second as well as of the first set may be connected all in series, in two parallel series or in three parallel series; under these conditions the difference of potential between the terminals in the case of single phase, or the difference of potential between phases, for triphase current, is respectively 6,600, 3,300 or 2,200 volts.

The field is formed of a heavy cast-iron flywheel mounted in the middle of the main engine shaft, around whose periphery are fixed 84 steel pole pieces by means of two bolts each; these are of circular section and their form and width are such that not only is the amount of copper for the winding a minimum, but the form of the electro-motive force curve is quite regular and nearly a sine curve. The winding is formed of insulated copper strips; for the excitation from 85 to 100 volts is used. The total weight of the field is about 37 tons. The total resistance is 0.70 ohm. To excite the fields at full load, with a factor of 0.7, takes 24 kilowatts, or one per cent of the total energy of the machine. The construction of the flywheel, considering its large dimensions, has presented some difficulty both for the magnetic effects and the resistance of the wheel; its total weight is 76 tons, only a quarter of this being necessary to furnish the iron of the magnetic circuit. The moment of inertia of this mass in movement is quite considerable. The regulating action of the flywheel is such that the irregularities of phase do not exceed one-five-hundredth and thus parallel working is easily obtained; it has been made larger than the mechanical and magnetic conditions require for security. To prevent air

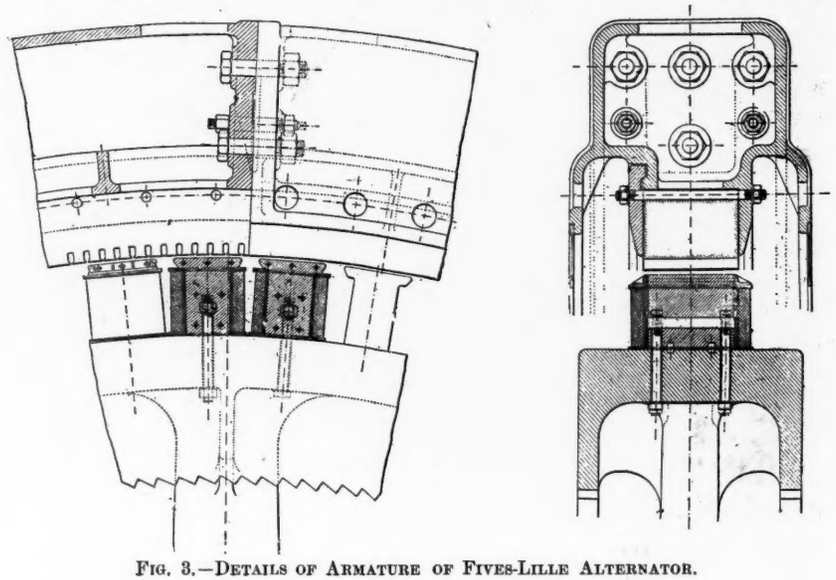


FIG. 3.—DETAILS OF ARMATURE OF FIVES-LILLE ALTERNATOR.

currents it has been covered on each side with iron plate. The external armature ring is made in six pieces, bolted together and having a number of openings for ventilation; on the interior are fixed the series of laminated rings forming the armature, which is made up of five separate rings with a space between each for ventilation. The whole is fixed against a flange forming part of the outer casting by a corresponding ring on the other side by a series of bolts. The ring carries on each side a projection for bolting it at the floor level and the lower part of the ring rests on a piece at the bottom of the pit; a series of wedges enables the machine to be centered exactly. The laminated ring has 672 slots for the winding, or eight per pole; six of these are used for the main winding and the outer two for the auxiliary winding, the armature ring being made up of five parts, four spaces are thus left between them, which communicate with the series of holes in the outer casting and good ventilation is obtained. The total weight of the armature is about 80 tons. The fields are excited by a small, direct-connected set, consisting of a six-pole generator mounted with an upright compound engine of the Schichau type; the generator gives 50 kilowatts at 110 volts, making 240 revolutions.

The engine has been built by the Augsburg-Nuremburg Company, and occupies a space 65 feet long, 40 feet wide and 20 feet total height. It gives 72 revolutions per minute. As will be seen in the figure, it has two groups of cylinders between which is mounted the alternator which serves as a flywheel. In front is the high-pressure cylinder in tandem with one of the low-pressure cylinders, while the opposite set consists of the mean and a low-pressure cylinder; the use of two low-pressure cylinders permits of increasing the piston speed and has some other advantages. The diameters of the three types of cylinders are 28, 44 and 46 inches diameter, respectively, with a common stroke of 64 inches. The steam distribution is made by double-seat valves which are operated by levers and cams from a main shaft passing along the cylinders on each side. The engine is well provided with indicating and regulating apparatus and has a speed indicator and a system of controlling levers, besides vacuum and pressure gauges, etc. The steam is supplied from five boilers, which form part of the German exhibit in the main boiler room and have been furnished by Berlin, Frankfort and other firms.

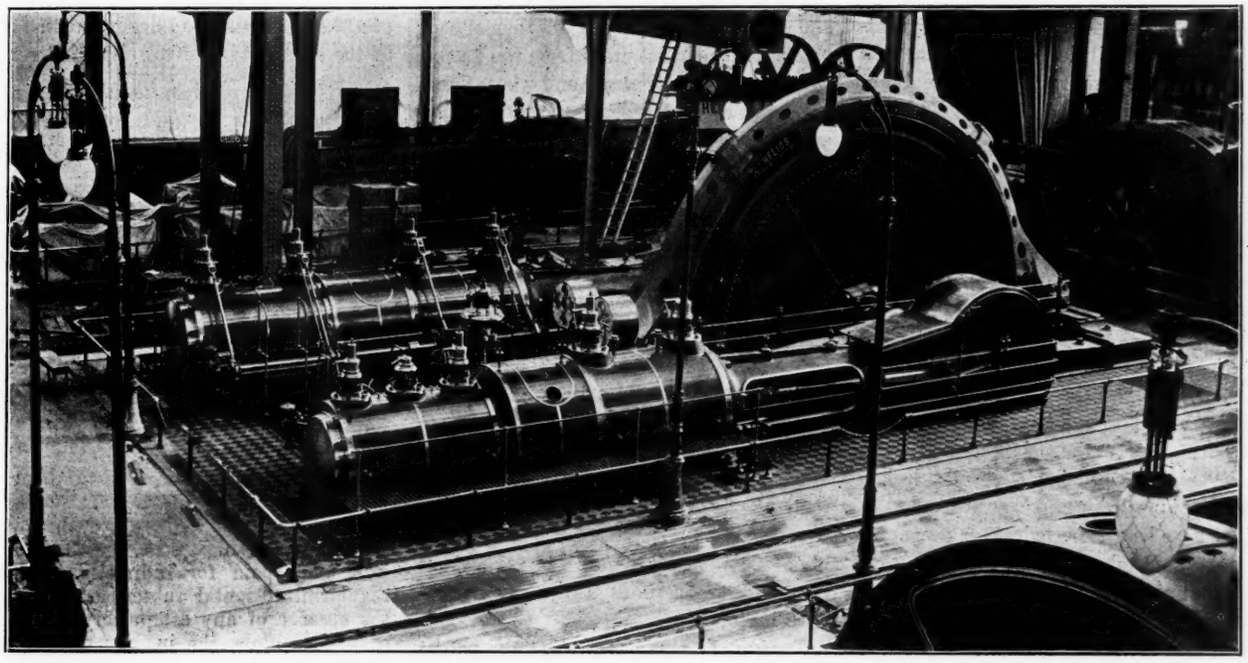


FIG. 4.—3,000-KILOWATT MULTIPLE CIRCUIT POLYPHASE GENERATOR AND TRIPLE EXPANSION ENGINE IN THE GERMAN SECTION OF THE PARIS EXPOSITION.

A Polyglot Technical Dictionary.

A reliable technical dictionary compiled in French, English and German, is considered by the Society of German Engineers to be a work of such necessity and importance that the society has requested the English and French societies to assist and appoint members to collaborate. The Englishmen, while in thorough sympathy with the proposed undertaking, can, for some unknown reason, take no official part in the work with their Berlin friends, but Sir W. H. White, president of the British association, stated that the names of any individual members who were willing to assist would be forwarded to Berlin.

It has not been stated as yet what action will be taken by the authorities of the French societies, but it is thought that they are favorably impressed, and will lend their assistance. Such a book, if properly compiled and collated by capable men, would prove of great value, and it is to be hoped that the plans of the Germans will meet with the success they deserve.

A Free Industrial Scholarship.

The Manufacturers' Association, of New York, at the suggestion of Mr. Ludwig Nissen, its president, recently appropriated the sum of $2,000 for an industrial scholarship, including the cost of tuition for four years and incidental expenses. The purpose of the association, in providing means for the industrial education of the young men of Greater New York, is to encourage young men to qualify themselves for leadership in industrial pursuits by adding to the dignity of labor the advantage of trained hands directed by developed minds. The association has appointed a commission to arrange details for and to conduct the examination of candidates. This commission, which does not include members of the Manufacturers' Association, is composed of the following named gentlemen: Hon. Alexander E. Orr, Rev. S. D. McConnell, Dr. Truman J. Backus, Hon. Henry W. Maxwell, and Associate Superintendent of Schools William L. Felter. The commission was recently organized by the election of Alexander E. Orr as president and William L. Felter as secretary. Plans are in course of preparation which in the near future will be publicly announced.

TELEPHONE PAY SYSTEMS; FIXED RENTALS AND MEASURED SERVICE OR TOLLS—I.

BY C. E. McCLUER.

When Professor A. Graham Bell made public his marvelous invention at the Centennial Exposition, in Philadelphia, in 1876, it aroused widespread interest, but was at first looked upon as a mere scientific toy.

It was not long, however, before the value and utility of the invention was discerned by a few enterprising individuals who conceived the idea of constructing a telephone exchange system and disposing of the service to such subscribers or patrons as might choose to avail themselves of the facilities offered them. At the outset the exchange plants and apparatus were exceedingly crude. The battery transmitter not yet having taken shape in the mind of the "Wizard of Menlo Park," the one instrument invented by Professor Bell was utilized as both receiver and transmitter, and the central office switching devices were patterned after the then existing types of telegraphic switchboards.

Telegraphers as a class looked askance at the telephone as a possible rival to the telegraph and would have nothing to do with it. Hence the original promoters, while being shrewd business men, lacked electrical knowledge and experience, and, as might have been expected, made numerous mistakes. Under the erroneous impression that the cost of construction, operation and maintenance of an exchange plant would be insignificant, they made the serious error of offering exchange service at such low figures as a limited experience proved would not pay operating expenses, much less a fair interest on the investment.

They soon discovered, also, that for every paying patron connected into an exchange they were required to serve an indefinite number of other persons who paid nothing whatever for the service. At first this was not considered an unmixed evil, as it was argued that non-subscribers allowed to utilize subscribers' telephones gratis, would soon discover the value and utility of the exchange and would themselves eventually be induced to become paying subscribers. But as the exchanges grew in size and importance, it was found that the expenses of operation and maintenance increased in a three or fourfold ratio with the income. As soon as this fact became apparent, together with another equally unwelcome fact that no matter how many paying patrons were added to the exchange catalogues every such addition brought with it a varying number of non-paying users, it was deemed absolutely necessary to enforce an increase of rates. And, as it is human to err, and as telephone managers of those days, like their successors of the present day, were only human, they swung the rate pendulum to the opposite extreme. It was quite natural that the transition to the higher rates from the inadequate rates adopted in the absence of guiding data, should be radical and pronounced. The "middle extreme" of the Virginia legislator was lost sight of and, arguing that if the installation of each station outfit was to be followed by a fourfold increase in service and expenses, the unhappy telephonist concluded that he must exact from the patron who executed his contract and whose name appeared on the exchange catalogue, an amount sufficient not only to compensate him for the service rendered the paying subscriber, but also to pay for the much larger service rendered his non-subscribing friends, customers and neighbors; sad experience having proved that the clause of the exchange contracts prohibiting the advantages of the service to non-subscribers was a dead letter, no one ever giving it the slightest consideration. Hence the fixed rentals originally adopted were doubled, trebled and, in many cases, even quadrupled and in spite of the protests of their helpless patrons were enforced, until the expiration of the fundamental telephone patent opened the way for serious competition and resulted in a pronounced lowering of rates.

During the many years that the patent laws of the United States very properly authorized and justified the existence of a wealthy and powerful telephone monopoly there was no redress for the exactions of the lessee or operating companies, and communities were politely advised that individuals who were unable or unwilling to pay the generally prohibitive rates, might exist as best they could without the convenience of a telephone upon their own premises. And they straightway proceeded to get even with the telephone company by making liberal use of their more wealthy neighbors' telephones gratis. While this state of affairs was well known to the telephone people, they were powerless to protect themselves, but they did not worry or make themselves unhappy as long as the few paying customers willingly or unwillingly continued to pay a handsome profit on the service rendered the entire community. The regular subscribers realized that they were being heavily taxed for the benefit of their "friends and countrymen," but, being unable to secure any diminution of the rates imposed upon them, and not being assessed any additional tax for the outsiders' use of their 'phones, although greatly inconvenienced and annoyed thereby, did not seriously protest.

The writer, an old-time telegrapher as well as a telephone pioneer, early in the history of the telephone was impressed with the fact that the fixed-rental systems, as then administered, were exceedingly inequitable, both to the operating companies and to the paying patron, and began the advocacy of a "toll" system long prior to the expiration of the Bell patent. In the Summer of 1892 was penned an argument in favor of the substitution of toll for fixed rental systems from which the following is quoted verbatim:

As long as regular telephone patrons pay not only for their own use of their telephones but also for the use of the exchange system by an unknown but doubtless very numerous array of individuals who themselves pay nothing whatever, the fixed-rental systems will hold sway. But just as soon as the revenues derived from fixed rental subscribers are materially reduced by competition, or municipal or legislative enactment, the telephone companies will be compelled to adopt some system or device by means of which they can protect themselves from the unjust imposition now practiced upon them by the non-subscribing public, and derive a reasonable revenue for a service which they are now rendering gratis, or which is at least only paid for indirectly by their regular fixed-rental subscribers. Or, in the absence of any compulsory reduction of fixed rentals, the introduction of underground conduit systems with their accompanying expensive metallic circuits and switchboards, may render an increase of revenue an indispensable necessity in order to pay anything like an adequate interest upon such heavy additional investments. But any material increase in the fixed rental rates will arouse opposition and result in a serious loss of patronage, if nothing worse. Just here the toll system would come into play and, if judiciously inaugurated and wisely administered, would, by securing a revenue from the entire public who now pay nothing for their telephone service, increase the revenues to a satisfactory degree. And if the tolls are wisely scaled for fixed-rental patrons, they could doubtless be made to pay in tolls more than they had been previously paying in contract rentals, and that without protest, as they would always know they were paying only for service actually rendered them, and could, at will, reduce their telephone expenses by restricting the use of their 'phones to important occasions only. The fixed-rental subscriber now undoubtedly burdens the patient and long-suffering telephone with much unnecessary and trivial correspond-

ence, simply because it costs him nothing extra.

The principal drawback to an ordinary toll system is the trouble, difficulty and expense of keeping a record of connections that the subscriber will accept as accurate and not feel disposed to question. But for the difficulties encountered in this direction, I believe that a large number of exchanges would to-day be operated under a toll system with greater profit to the proprietors and a far greater amount of satisfaction on the part of their patrons, than is now experienced in connection with the fixed rental systems.

The demand for reduced rates will undoubtedly grow stronger, and the telephone companies will, in the near future, I firmly believe, find it necessary to protect themselves from imposition and avert organized strikes for lower rates by throwing open their exchange service to the entire public, and conceding more equitable terms to their regular patrons by the adoption of toll systems, with the tolls so scaled that large users will not be unfairly taxed, but will pay in proportion to the value of the service rendered them, while small users will be encouraged by a rate that will justify them in according their moderate patronage, and, at the same time, amply compensate the owners of the plant.

As long as the fixed-rental systems are maintained after the expiration of the fundamental patent, so long will the telephone field invite competition of a speculative character. No matter if the experience of operating companies during the past years demonstrates that exchange systems can not be profitably operated at rates lower than those exacted from their patrons; no matter if their expenses are increasing with the growth of their exchanges in a much greater ratio than their receipts, thus forcing upon the minds of their executive officers the unwelcome conviction that some time in the near future they will be compelled to increase rates, quit business, or continue at a loss; no matter for all this, the men and means will be forthcoming to inaugurate telephone exchange enterprises at rates much below those of the companies already occupying the field. Many subscribers to the existing exchanges will be seduced from their allegiance by the bait of reduced rates, and will encourage and support opposition in order to attain that end, oblivious of the fact that even if the opposition company succeeds in maintaining its enterprise, they will have to patronize both companies in order to secure the full benefit of the local exchange service.

All this could doubtless be avoided by the speedy inauguration of wisely installed and properly administered toll systems, thus placing the advantages of the exchange within the reach of all classes of citizens, popularizing the service and greatly extending its usefulness and enhancing its value, and leaving no tenable ground for the speculative opposition agitator to stand upon.

I believe a comprehensive toll system would stave off ruinous opposition.

But before a generally satisfactory toll system, one that will prove satisfactory to all parties concerned, can be inaugurated, the cumbrous and unsatisfactory manner in which the records of connections are now kept must give way to one more in consonance with the spirit of the times, one in which the agency of fallible men and women is superseded by automatic appliances whose records can be accepted by company and patron as absolutely correct.

From another paper by the same writer, published in the ELECTRICAL REVIEW of January 24, 1891, I quote the following:

The near approach of July, 1893, a month of paramount interest to the telephonic fraternity, is heralded by the advent of a numerous array of devices intended to provide for the ready substitution of telephone "toll" systems for the "fixed-rental" systems now almost universally in vogue. As long as the telephone companies possess the rights conferred upon them by the operation of our domestic patent laws, they are able to establish and maintain fixed rates for specified terms, which are sufficiently lucrative to enable them to stand the imposition practiced upon them by non-subscribers; but upon the expiration of the fundamental telephone patent granted to Professor Bell in 1876, it is highly probable that the rates now charged for telephone service will be materially reduced. As the margin between receipts and expenditures becomes narrowed by the reduction of rates, followed by increased patronage and the usual disproportionate increase in operating expenses, the illegal use of subscribers' telephones by non-subscribers will become a burden too grievous to be longer borne by the patient and long-suffering telephonist, and resort will necessarily be had to some system more equitable than the fixed-rental system. The toll system will then undoubtedly come to the front and the telephone companies will very probably be compelled to adopt such a system in self defence.

The predictions contained in the above extracts are being rapidly verified. While few, if any, purely toll-system exchanges have yet been inaugurated, a kindred system has been devised and is being extensively introduced in our larger exchanges. This, while denominated a "measured service" system, is in reality a modified toll system, the telephone patron contracting to pay a stipulated tax for a designated number of connections, the rates per connection being so scaled that the larger the number of connections contracted for or actually secured during a stated period, the lower the rate per connection. This admirable introduction of the commercial wholesale and retail feature is worthy of universal adoption. The wholesale customer gets his service at the lowest or wholesale rate, while the retail purchaser pays the maximum or retail figures for his moderate demands. In case the stipulated number of connections contracted for should be exceeded, the customer is taxed an additional amount in proportion to the excess. This is a very commendable variation from the out and out toll system under which a fixed and unvarying charge is made for each connection, and is really tantamount to offering the exchange service at rates scaled according to the number of connections had within a given period. The only difference is one that will commend the scheme to telephone managers. The "measured service" patron can be, and I presume usually is, required to pay in advance for the number of connections called for by his contract, while the scaled rate toll subscriber can be assessed only after service has been rendered.

But in either case the unsatisfactory feature of both the measured service and the scaled rate systems, lies in the fact that the records are necessarily, in the absence of a better arrangement, kept by the employees of the party to the contract whose duty it is to furnish the service for which the other party is required to pay. Unless, therefore, it is assumed and admitted by the purchaser that the operators or other employees of the telephone company charged with the duty of keeping the records and making out the bills are infallable, contention is very apt to ensue when pay day rolls around. Even if the patron attempts to check the office records by keeping a record of his own, the two will rarely agree, the office figures almost invariably exceeding those of the subscriber, who will very naturally conceive that he is being imposed upon. The officers of the company, knowing that their employees could have no possible reason for falsifying the records purposely, must either insist upon their infallability and adopt the highwayman's demand with a variation, "your money or your telephones," or effect a compromise. In either event the subscriber will consider himself aggrieved and will bide his opportunity for getting even.

Hence, a simple, cheap and reliable connection meter or recorder is a desideratum.

A Telephone System for Mines.

Telephone and telegraph lines will connect all the mines of the Mountain Telegraph Company, which are located in the states of Wyoming, Colorado and New Mexico. It is understood that this corporation is owned by the officials of the Colorado Fuel and Iron Company, who capitalized it at $1,000,000. The system will be a private one not connected with any outside lines.

Science Brevities

Platinum-Silicium Resistances—A short article in the *Elektrotechnische Zeitschrift* by Herr Victor Rodt describes some experiments conducted with a view to ascertaining the chemical resisting qualities of platinum-silicium resistances. Resistances consisting of a thin film of the alloy fused on to porcelain rods have been recently introduced by a German firm, we are told. The rods have a length of 2.83 inches to 4.75 inches, and a diameter of about 0.2 inch. Although originally intended for use in connection with electrical heating apparatus, it is concluded by the writer that these resistances are also eminently adapted for work where chemical action has to be guarded against. However, the suitability of the resistances for making accurate measurements has not yet been determined, nor do the methods hitherto employed of connecting the platinum-silicium with the conductor exclude the possibility of slight fluctuations of the current density. On the other hand, the resistance offered against overloading, not to mention chemical and thermal influences, confers upon this form of resistance such advantages for certain classes of work that its use deserves consideration.

Secondary Electrolytic Action—If after the electrolysis of a concentrated solution of "hypo" (sodium hypochlorite) the quantity remaining in solution is determined, it is found that the quantity which has disappeared does not correspond to that calculated from the transformation of the hypochlorite at the cathode, and of the formation of chlorate at the anode. More hypochlorite disappears than is foreseen by the theory, and too much chlorate appears. The amount of the error is very great, often attaining over 25 per cent, and it increases with the concentration of the salt. M. A. Brochet accounts for this irregularity in the following manner, says the *Electrician:* The immediate neighborhood of the anode is always acid; hence, beside the hypochlorous acid transformed into chloric acid by the current, some of the highly concentrated acid undergoes spontaneous oxidation. An attempt to produce this phenomenon at feeble concentrations failed, owing to the impossibility of obtaining consistent values. The secondary electrolytic action is the reason why no hypo solution can be effectively electrolyzed with a concentration amounting to more than 12.7 grammes of active chlorine per litre.

Magnetization and Torsion—From the ample materials supplied by Grösser, Herr K. Schreber has unraveled the following regularities in the complicated relations between magnetization and torsion, says M. Fournier d'Albe: Every iron or steel wire free from torsion acquires a permanent twist under magnetization, which, with increasing field intensity, tends towards a maximum. The direction of the torsion is, strange to say, independent of the direction of magnetization. In fact, it is reversed several times in the same wire as the field increases in strength. In iron the previous history of the wire does not seem to affect the amount of the twist, but in steel it does, to an extent which can not as yet be stated in a simple manner. Moreover, the permanent twist is greater in steel than in iron. Besides the permanent twist, the wire experiences a temporary twist, which increases with the field as soon as the permanent twist has attained its maximum. Beyond that maximum, also, the temporary twist has always the same sign. An eye looking along the lines of force would always see the twist taking place in the direction of the hands of a watch. This practically diminishes the torsional elasticity in that direction. The observation recalls the phenomenon of the twisting of cathode rays in a magnetic field running along them.

Frequency of Alternate Currents—Herr A. Samojloff has accidently discovered a very simple method of determining the frequency of an alternating electric light current. M. Fournier d'Albe summarizes his results as follows: In the course of some physiological experiments on the intermittent excitation of the retina, made with a disk consisting of black and white sectors, he noticed that when illuminated by a glow lamp the disk appeared to stand still when revolving at a certain rate. That rate was the rate at which the alternations of black and white at any given point of the disk were synchronous with the alternations of the luminosity. The periodical partial extinctions of the filament, though imperceptible to the eye, were evidently sufficient to make the intermediate grades between a maximum or minimum of whiteness disappear, and thus to produce the appearance of a disk at rest. Hence it is only necessary to place a revolving disk near the lamp and to alter its speed until it appears to stand still. The number of white sectors, multiplied by the revolutions per second, gives the number of reversals per second of the current. The frequency of a Wehnelt interrupter may be similarly determined by mounting it in parallel with an arc lamp and treating the latter as an alternate-current lamp. This may be done in daylight.

Non-Permanence of Weight—The whole system of modern chemistry is based upon the axiom of the indestructibility of matter, and that indestructibility is proved by the permanence of the weight of a given substance through all the physical or chemical changes it is made to undergo, says M. Fournier d'Albe, in the *Electrician.* Any experiments, therefore, which shake our belief in that primary property of matter must have a far-reaching effect. Landolt's classical researches in 1893 (for which see the *Zeitschrift für Physikalische Chemie* of that year) embodied the first work done with all the modern instruments of precision. Certain minute changes of weight were then placed in evidence, and these have since been confirmed. Herr A. Heydweiller has endeavored to trace some connection between the change of weight and the changes in other physical properties, such as magnetic permeability, electrolytic dissociation, and material or optical density. He has failed to trace any such connection, though he has distinctly established a diminution of weight of about 1 part in 50,000,000 in a number of reactions, such as the mixture of copper sulphate with water, where a loss of weight of 1 milligramme was observed. Researches such as these take place in the extreme borderland of science, but the logical outcome of the results would be nothing less than the destruction of matter.

Atmospheric Potential During a Solar Eclipse—Some time ago, Signor Oddone published the results of an attempt to discover an influence of a solar eclipse upon the atmospheric potential. The results were very doubtful. There appeared to be a slight increase of positive potential, but that may have been due to the formation of clouds. Herr J. Elster was so fortunate as to take some observations near the town of Algiers, within the area of totality, during the recent eclipse, and therefore of much greater importance than the Pavia observations. He found a steady and decided diminution of the positive potential from 177 volts at 12.30 P. M., to four minutes after totality, which occurred at 4.29 P. M. The minimum observed was 113 volts, and at 5.47 P. M. the orginal potential was nearly attained. This looks like a well-established connection between potential and solar illumination of the atmosphere. The author inclines to the opinion that during the

eclipse masses of air were aspirated from the sea which had different electric charges. As a matter of fact, a fresh breeze was blowing in from the sea during the whole afternoon. The result is directly opposed to that of Oddone, at Pavia, unless we assume that there is some casual connection between them, remarks M. Fournier d'Albe. On the other hand, the new observation corroborates that at Wolfenbüttel, in 1889, which showed an increase of positive potential after totality.

A New Battery Switch - Some of our German contemporaries describe a new type of accumulator switch which is designed to avoid the necessity of employing a booster to furnish the extra voltage for charging when the charging dynamo is required to provide current at the normal voltage for other purposes at the same time. The new switch effects this end by enabling two-thirds of the total number of cells contained in the battery to be always charged together, says the *Electrical Engineer*. It is pointed out that for a battery having a capacity of 100 amperes at 110 volts terminal pressure, 60 elements are necessary. The mean charging pressure required per element is 2.4 volts. When charging the battery in parallel halves, there are 30 elements in each half, for the charging of which $2.4\times30=72$ volts mean charging pressure is necessary. But since the line pressure is 110 volts, $110-72=38$ volts, with a current of 100 amperes per half—that is to say, a total of $2\times100\times38=7{,}600$ watts, or about 11.7 horse-power must be choked back by means of resistances. The driving engine is called upon to furnish about 34 horse-power for the charging process alone. If, on the other hand, we charge two-thirds of the total number of cells—that is to say, 40 elements, which will require $40\times2.4=96$ volts—there will be only $110-96=14$ volts to choke by means of resistances, which, with 100 amperes, represents about 22 horse-power, while the driving engine is called upon for only 17 horse-power. Extensive application of this method of charging has been prevented hitherto by the absence of a switch which would enable the individual thirds of the battery to be switched together as desired without the possibility of error. But this difficulty is claimed to have been satisfactorily overcome by the new switch introduced by Dr. Paul Meyer.

Electrical Utilization of Wind Power—A promising experimental plant, consisting of a windmill, a dynamo, a battery of accumulators, and electric motors, have been put up at Wittkiel, near Kappeln, situated at the entrance of the Schlei, the longest of the narrow fjords which the Baltic sends into Schleswig. Success seems to be chiefly due to improvements in the wind motor, which has been constructed by C. P. Neumann, of Wittkiel. The motor is distinguished by large dimensions and large inertia; it has a diameter of 12 metres (39 feet), and an effective wind area of 100 square metres (about 1,000 square feet), and can develop more than 30 horse-power. Its normal speed is 11 revolutions per minute, and the speed is maintained by an automatic adjustment of the vanes. The *Elektrotechnische Zeitscrift*, in which the installation is described, does not give any further particulars. The electric installation has been erected by the Gustav Conz Electric Company, of Hamburg, on whose behalf the experiments are being conducted. The shunt wound dynamo yields, at 700 revolutions, 160 volts and 120 amperes, and attains this full electro-motive force when the wind velocity exceeds eight feet per second. The positive field terminal is permanently connected with the battery pole, the other is joined to the switch of the regulating cells in the charging circuit. No manual regulation of the dynamo is said to be required, and no automatic device for disconnecting the dynamo has been provided for, as the motor keeps its speed up well. The voltage in the discharge circuit is maintained at 110 volts by another automatic switch. The external circuit of the battery contains lamps and small electric motors. Large electric motors are directly connected with the dynamo, and starters and speed regulators are inserted in these connections. The plant is to be permanent and to light the town of Wittkiel. A larger installation, comprising several wind motors and dynamos, is planned.

Magnetic Field Due to a Moving Electric Charge—As a further test of the mutual action between a moving charge and a magnetic field, M. V. Crémieu has tried whether any converse effect is produced, *i.e.*, whether a changing magnetic field produces any motion of an electric charge suspended in it. The apparatus consists essentially of an aluminum disk mounted in a glass frame and suspended by three silver wires close together. The disk is perforated in the middle so as to allow the core of an electromagnet to traverse it without touching it. The coils of the electromagnet nearly touch the disk above and below. The disk is divided into two portions joined by plates of mica, so that when it is charged through the silver suspension there are two separate charged bodies in the magnetic field. The force experienced by each charge should be

$$\epsilon\frac{dH}{dt}$$

where ϵ is the charge and H the field. Hence the working of the magnetizing circuit should produce a deflection of the suspended disk. The moment of the force should have been 600 to 800×10^{-6} ergs, which should have given a deflection of 10 centimetres to 14 centimetres on the scale used. But no deflection whatever was observed, thus confirming the negative result previously obtained. The author, therefore, says an *Electrician* abstract, again concludes that there is no force experienced by a moving charge in a magnetic field.

An Explosion of Scientific Interest—A singular though not unprecedented accident took place at the Mammoth mine, in Utah, recently, illustrating applied thermodynamics in an interesting but fatal manner, causing the death of one and the severe injury of another of the engineers of the mine, says Professor R. H. Thurston, in *Science*. The cylinder of an air-compressor exploded while in operation in regular work, and with such violence as gave evidence of more than the action of the normal air-pressure in its production. The back cylinder-head and the cylinder itself were shattered; the violence of the explosion was terrific. The two men were thrown across the room and badly mangled and one instantly killed. Fragments of metal and of flesh were found outside the building and a long distance away. The air-pressure, at delivery from the compressor, was but 80 pounds per square inch. The cause of the explosion is presumed to have been the compression of the vapors of petroleum given off by oil used for lubrication in too large quantity and of too light a quality. Mingled with air in the right proportion for combustion, the mixture of air and vapor was heated by thermodynamic action of compression, approximately adiabatic up to the temperature of ignition, and the explosion followed. This action is precisely that relied upon in the Diesel gas-engine, recently attracting so much attention, for the ignition of its charge independently of gas-torch or electric spark. The phenomenon has long been known to the engineering profession, although instances of this kind of accident are rare. The use of effective methods of cooling the compressor-cylinder and the employment of lubricating oils of high flashing point constitute the preventives.

BOOK REVIEWS.

"The Progress of Invention in the Nineteenth Century." By Edward W. Byrn. Large octavo, 480 pages, 300 illustrations. Cloth. Published by Munn & Company, New York. Supplied by the ELECTRICAL REVIEW at $3.00.

Mr. Byrn has succeeded in collecting within reasonable compass a highly interesting account of the progress of invention, or, in other words, the progress of civilization, in the nineteenth century, and the publishers have put his work into handsome and substantial shape. The book treats of the whole subject of invention, taking up such subjects as the telegraph, the dynamo and its applications, the motor, the electric light, telephones, miscellaneous applications of electricity, steam engines, railroads, steam navigation, printing, typewriting, sewing machinery, agricultural machinery, rubber, mechanical processes, food and drink, and so on through the whole category of inventions, even including liquid air. The author is not, however, particularly enthusiastic about the latter subject. The work is well illustrated and has excellent indexes so that it is a work of reference as well as one of general reading. In either capacity it is well worth having.

"Free-Hand Perspective." By Victor T. Wilson. Octavo, 280 pages, 139 illustrations. Cloth. Published by John Wiley & Sons. Supplied by the ELECTRICAL REVIEW at $2.50.

While this book is intended to be used in connection with a course of model drawing for general students, either in schools or colleges, it is such a good practical treatise that it is worth the reading of engineers, or, indeed, of any men in practical life who have occasion to use the lead pencil in sketching. The book is one that seems to deserve success because of its attractive presentation of an old subject in a new and original way.

"Dynamo Electric Machinery: Its Construction, Design and Operation." By Samuel Sheldon. Five and one-half by eight inches. 281 pages, 202 illustrations. Cloth. Published by D. Van Nostrand & Company, New York. Supplied by the ELECTRICAL REVIEW at $2.50.

This volume is confined to direct-current dynamos and motors and was intended to be used in connection with instruction in electrical engineering courses, though also adapted as a book of general reference for engineers and for the instruction of the more serious inquirers after information. While the calculus has been used in a few instances, the results arrived at are in such forms that they can be utilized by the reader unfamiliar with this branch of mathematics. The book is simple and straightforward in its method and seems to be one of the most sensible and useful treatises of its kind that has yet appeared.

"Theory and Calculation of Alternating-Current Phenomena." By Charles P. Steinmetz. Third edition, revised and enlarged. Six by nine and one-half inches. 525 pages, 210 illustrations. Cloth. Published by the *Electrical World and Engineer*, New York. Supplied by the ELECTRICAL REVIEW at $4.00.

Mr. Steinmetz, in preparing this new edition of his classical work, has added considerable new material and also rewritten, in large part, some of the older chapters. The typographical errors which were noticeable in earlier editions have been, for the most part, eliminated. The new chapters include those on vector representation of double-frequency quantities, such as power and torque, and upon the symbolic representation of general alternating waves. The appearance of the volume is very handsome and care has been taken to make the notation throughout consistent. The work will doubtless meet with the extended recognition that the great ability of its author commands.

London Streets Obstructed.

The contractors who are laying the mains for the post office telephones in the city of London, England, are proceeding in a very leisurely and complacent manner, greatly to the inconvenience and complication of the citizens. It might be reasonably supposed that such work, traversing, as it does, the busy thoroughfares of the largest city in the world, would be rushed through in the night as soon as possible, but it seems this is not the case and it is stated, although we have no confirmation of the report, that no night work is being done, says the *Electrician*.

With the great number of vehicles and the heavy traffic that is hourly passing over the thoroughfares in which the work is being done, the tearing up of the streets, and the consequent piles of cobble-stones, earth, tools, appliances, manhole covers and all the familiar sights that attend excavations in the city streets, it is little to be wondered at that the Britons are inclined to soreness in the matter. The city engineer endeavored, without success, to compel the postal system to engage men for night work and by that means hasten the construction work, and reported his failure to the Court of Common Council. The court, as a body, appealed to the post office officials, who have said that they would at least give the matter consideration. In the meantime nothing particularly is being done regarding it, and the obstructions still exist, and inconvenience to pedestrians, vehicles and the general public continues unabated.

A NEW CONSTANT-POTENTIAL CONTINUOUS CURRENT TRANSFORMER.*

BY F. W. DAVIES.

There are probably few electrical engineers, who have had much practical experience in the running of continuous current transformers, but have realized the advantages of employing machines that would give a constant potential at all loads, thus avoiding the necessity of compensating for the voltage drop in the secondary at full load by means of a small "booster."

The writer's object is to describe, as briefly and concisely as possible, a simple method of compensating for the voltage drop in the secondary at full load, which he has discovered. This method is analogous in its effects to the "compounding" of a dynamo, and the winding of the same, like the series winding of a compound dynamo, may be so proportioned that the secondary voltage at full load is either less than, equal to, or greater than the voltage on open circuit, corresponding to the "under-compounding," compounding" and "over-compounding," respectively, of a dynamo. It can easily be adapted to existing designs, and, as the writer has not protected it by Letters Patent, some engineers may possibly consider it worth their while to adopt it. It is applicable only to transformers of the single field type, where both the primary and secondary armature windings are wound upon one core, and not to those machines which consist of a dynamo and motor mounted on one bedplate, with their armatures rigidly coupled together.

It is proposed to vary the ratio of transformation as the load increases by means of a particular arrangement of the armature winding used in conjunction with a special compensating winding on the field magnet; this variation in the ratio of transformation to be such that the electromotive force in the secondary circuit shall be raised by the amount necessary to compensate for the loss in volts at the increased load.

For the sake of simplicity a two-pole machine is considered, the same principle being easily extended so as to include multipolar machines. The principle of construction is as follows: The field magnet may be of any type, but each pole must be provided with a slot in which the compensating coil is wound as shown (see Fig. 1). These coils must be connected in series with the secondary circuit, and connected up so as to assist the main magnet winding. Their function is to strengthen the

*From the London *Electrical Review*.

flux in the magnet pole on one side of the slot and to weaken it on the other side; in other words, the object is to concentrate the lines of force of the field magnet within the area enclosed by the compensating coils. The armature is shown in Fig. 2.

To render the winding more clear only two coils, one primary and one secondary coil, have been shown. The primary coil is wound with any usual pitch, provided it is sufficiently great for the coil to enclose the whole armature flux when the coil is in the neutral position, that is, with its plane at right angles to the field. The secondary coil, as will be seen, is chord wound. Its pitch should be such that it just encloses the lines of force which pass through the compensating coil, but it should not enclose any more than this. In other words, the angular pitch of the coil must be approximately the same as the angle θ (Fig. 1). A diagram of the complete armature, showing six coils in the primary winding and six coils in the secondary winding, is shown in Fig. 3.

The action of the transformer is very simple. At light load when there is no current in the compensating coils, those lines of force which are embraced by the compensating coils, are usefully cut by both the primary and secondary windings, but the remainder (*i.e.*, those passing through the small polar horn on the other side of the slot in the pole piece) are useless as far as the production of electro-motive force in the secondary winding is concerned, owing to the small pitch of the coils in the secondary winding (both limbs of a coil being under the same pole for a certain period in each revolution of the armature). This makes the ratio of the secondary volts to the primary volts less than it otherwise would be. But as the load increases the compensating coils begin to act. They divert some of the lines from the small polar horn and drive them through the polar area enclosed by the compensating coils, the total flux remaining practically constant. The result is that a larger proportion of the lines is usefully cut by the secondary winding, until at full load practically the whole of the flux is available for producing the electro-motive force in the secondary winding, and the ratio of transformation is then the same as the ratio of the total number of active conductors in the two windings, less the loss in the internal resistance of each armature winding. The effect of this is that the transformation ratio $\frac{\text{Secondary Electro-Motive Force}}{\text{Primary Electro-Motive Force}}$ is greater at full load than at light load, and by designing on these lines the pitch of the secondary armature winding and the number of turns on the compensating coils may be so proportioned as to give any desired rise of secondary electro-motive force at full load.

The above arrangement may, of course, be modified in various ways, although the general construction above described is probably the best. For instance, instead of the single slot in the magnet pole shown in Fig. 1, two slots may be used, and the compensating coils wound in them, as shown in Fig. 4. The chief disadvantage with this construction would be that, owing to the weakening of the polar horns by the compensating coils, it would be difficult to get that essential for good commutation — a strong reversing field. Then, again, a ring armature may be employed in place of the drum armature if desired. In this case a winding of the secondary, similar to that shown in Fig. 5, might be used.

The invention above described can also be applied to machines having four poles and upwards; it being essential, of course, that the coils in the secondary winding are of such a pitch that they only embrace a part of the total magnetic flux at light load, the variation in the ratio of transformation from light load to full load being obtained as in the case of two-pole machines by means of compensating coils on the magnet poles. In any case, the principle of compensating for the drop in the secondary by means of varying the ratio of transformation—this variation being obtained by means of compensating coils wound on the magnet poles in the manner above described—remains the same.

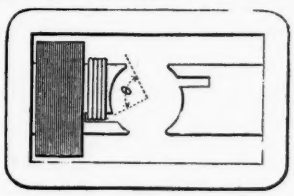


FIG. 1.—SHOWING COILS REMOVED FROM ONE POLE.

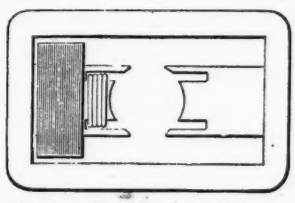
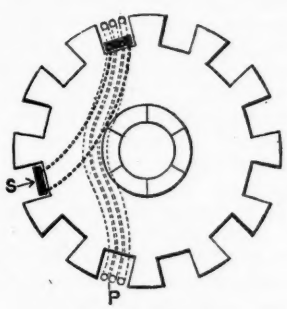


FIG. 4.—SHOWING COILS REMOVED FROM ONE POLE.



s, Secondary; p, Primary.

FIG. 2.

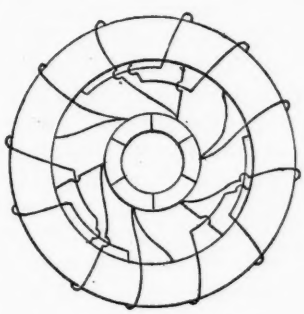


FIG. 5.

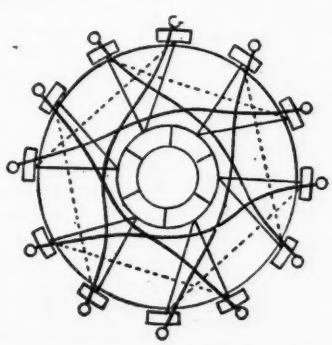


FIG. 3.—WINDING DIAGRAM SHOWING CONNECTIONS AT SECONDARY COMMUTATOR. (Secondary Coils represented by rectangular bars; Primary by small round bars.)

An injunction against the laying of its rails over the Holton street viaduct was recently feared by the Milwaukee Electric Railway & Lighting Company. A large gang of men were set to work in the night and succeeded in putting almost all of the rails down and erecting the trolley poles before an injunction could be served. The lawyers of Milwaukee say that the action of the company was a little hasty, as the injunction had been overruled by the Supreme Court, and that it was probable that formal permission for laying the tracks would have been granted.

ELECTRICAL ENTERPRISE IN ARGENTINA.*

BY ERNESTO DANVERS.

Electrical enterprise has received great impetus in this country during the past three years, and there is still a large field open to it, but before proceeding further I wish to draw attention to a point which is of the utmost importance in connection with its further development; this point is taxation.

As you will see later on, I have endeavored to show how existing electrical enterprises are taxed, and you will then easily understand that, while this heavy burden is placed upon them, few new enterprises will be likely to enter the field.

It is difficult for outsiders to understand the opposition which is shown throughout the country by the municipal authorities to such public enterprises as electric light and traction. They are to-day fully recognized as factors necessary to the civilization of large cities; and in most parts of the world, such corporations are encouraged rather than impeded by heavy taxes. The principal complaint of these corporations is that, having obtained their concession and having invested large sums of money, they are mulcted most unmercifully.

We may cite as an instance the light companies in Buenos Aires which are compelled to hand over five per cent of their gross receipts, whilst the tramway companies have to pay six per cent. This taxation is out of all proportion to the advantages conceded by the authorities.

To impose taxes which can only be considered as ruinous to new industries is surely not the way to extend industries nor yet to bring fresh capital into the country. The reason why there are not more electric trams in Buenos Aires at the present time, is that the municipal authorities imposed upon each company, after it had obtained its concession, the unreasonable demand of lighting every street through which it might pass. Fortunately this tax was repealed, but only when the authorities were convinced that if it were put into force the existing electric tramways would have to disappear.

Our authorities appear to lose sight of the fact that their hostile attitude will only serve to keep fresh capital from coming into the country.

We have here a wide field for electrical enterprise, and large tracts of mining territory awaiting the development of electrical power stations to open up the wealth that is lying beneath the soil, but for this we require capital, and this will not come so long as the authorities persist in creating taxes which render all investments unremunerative.

The daily press is already drawing attention to this matter, and it is to be hoped that the future welfare of the country and its steady development will not be checked by a continuance of this suicidal legislation.

As there are different branches of electricity to be treated upon, I shall take them in the order in which they have been adopted in the country and commence with telegraphs.

TELEGRAPHS.

The telegraph system of Argentina includes national, provincial, railway and private companies' lines, and all belong to the "Argentine Convention," which also includes those of neighboring states.

The tariff is uniform over the different systems. The lines are all aerial, and the construction is on iron, palm, or quebracho poles. Now that the forests of quebracho are brought within easy transport by means of the railway, quebracho poles are coming largely into use, as they are the most durable of any yet known. The wire is generally No. 7 galvanized iron, although the cable companies employ copper.

The insulators are of the Bell pattern. The cost of construction varies from $155 per kilometre to $300 and even more in outlying districts. In accordance with Art. 4 of the National Telegraph Law of October 7, 1875, no national line may be built (that is, a line in the federal capital or joining up two or more provinces) without the sanction of the national government, and, in case of a guarantee, without that of congress.

The railway lines and those of the private companies come under the jurisdiction of the post office.

In 1896 the revenue of the National Telegraph Department amounted to $1,133,707, and in 1897 to $1,182,056.

The tariff for national and private lines which form part of the Argentine convention is as follows, the minimum number of words being taken as 10.

For each word up to 10, five cents per word, and three cents for each of the following words.

There are also special tariffs for urgent messages, telegraphic conferences, etc., but these need scarcely be dealt with here. The cable companies which do not have land lines can only send their messages over the lines of the nation, to any point within the country.

All telegraph material for existing lines is imported duty free. The usual duties range from 5 to 25 per cent.

All supplies for the post office are called for by tender, and are principally supplied by English and German firms.

In 1899,the Marconi system of wireless telegraphy was introduced with a view of revalidating the patents. This system will in all probability be adopted by the Argentina Government, for the far South, and also for communications between Martín García and the mainland.

The first telegraph line constructed in this country dates back to August 30, 1857 and belonged to the Western Railway of Buenos Aires, the first railroad built in the country, which was inaugurated on the same day. This line belonged to the Province of Buenos Aires, and its length was only 10 kilometres; the instruments used were those of the Breguet pattern. From this date to 1869 the length of the telegraph lines did not increase much, but, on May 7 of that year, a line was opened to Rosario with a length of 410 kilometres. The Province of Buenos Aires built the line up to Arroyo del Medio, the boundary between the two provinces and the National Government continued the line to Rosario. About the same time, the towns of Mercedes, Carmen, Salto, Rojas, Pergamino and San Nicolás were placed in telegraphic communication with the capital.

The instruments used were of the Morse pattern. All the early lines were constructed by the Province of Buenos Aires, and it was only in the seventies that the National Government commenced the construction of lines, and this was due to President Sarmiento who saw how essential it was for the welfare of the nation to have the different parts of this vast territory connected by the electric telegraph. He had, however, to fight hard for his object, and on being interpellated by the Chamber of Deputies for having used some of the money provided in the budget for "Bridges and Roads" for the construction of the lines he replied, in his genial and brusk manner, that he had spent the money in building "the bridge of the word." He brought out a telegraph engineer from Europe and laid the foundation for the National telegraph system of to-day.

At the end of 1897, which is the latest data to hand from the telegraph department's annual report, the length of line was 18,531 kilometres, and of the conductors 41,038 kilometres. The number of offices was 383, and the number of telegrams sent was 5,296,194, which for a population of 4,029,541 inhabitants gives an average of 1.314 telegrams per inhabitant.

To-day the length of line is 19,609 kilometres and of conductors 44,578 kilometres with 465 offices.

In June, 1898, there were 1,544 telegraph offices in the country, of which 422 belonged to the nation.

Attached to the central office in Buenos Aires there is a school of telegraphy, and the department has also a very well mounted workshop for repairs and also for manufacturing instruments.

*Extracts from a paper read before the Institution of Engineers of the River Plate, Buenos Aires, Argentina, 1900.

At the present time the majority of the lines are being placed in a thorough state of repair so as to allow of the use of more rapid transmissions.

After the national department come those of the provinces of Buenos Aires and Entre Rios, which are the only two that have undertaken the construction of telegraph lines.

The province of Buenos Aires, as I have already stated, was the first to construct a telegraph line in the country, and it has continued to improve and increase its system until to-day it has 4,471 kilometres of line with 6,941 kilometres of conductors.

The instruments used are the Morse of the most approved pattern. There are 104 offices and, with the exception of three, all the remaining districts of the province have a station. These three will shortly be connected up, as the lines have been surveyed and the material purchased.

The average cost of the lines in this province is $247.49 per kilometre, using palm poles. The total number of employees is 478. In 1898 the telegrams numbered 1,430,483, and the revenue $527,959.

I next come to the telegraph department of the province of Entre Rios, which was created in 1886 for telegraph and telephone service, but the latter service was not a success for various reasons, and therefore it was resolved to limit the service to the telegraph alone.

The lines were first constructed with white palm posts which soon became unserviceable, but these are now being changed for red quebracho.

The first line was constructed in 1887 and to-day the province owns 1,211 kilometres of line and will shortly construct 188 kilometres to complete the system.

There are 22 offices and, in 1899, the messages numbered 107,423, producing a revenue of $87,150. The average cost of construction is $220 per kilometre. The average salary of telegraph clerks is $62.-80 per month.

The instruments are of the Morse pattern.

The railway lines are the next to be taken into consideration and at the end of 1899 their length amounted to 16,-408 kilometres, with 35,495 kilometres of conductors. These lines are principally for the private use of the railway companies, but they are also largely patronized by the public as the service is better than that of the national department.

The private telegraph companies are four, and these are all cable companies which own their land lines and their cable stations. Three are foreign and the fourth is Argentina, which possesses a land line and cable between Buenos Aires and Montevideo. There are two companies with land lines over the Andes to the cable stations at Valparaiso, Chili, and one with a land line and cable between Buenos Aires and Montevideo, where it joins up with the European cable system.

The private companies are taxed by the National Government and have to pay a yearly impost of $1,000 for the head office, and $50 for each branch office, and to the municipality of $2 to $4 for every post in the street, according to the district.

The total length of telegraph lines in the Republic to date is as follows:

	Lines.	Conductors.
National	19,609 kilom.	44,578 kilom.
Provincial	5,682 "	8,741 "
Railways	16,408 "	35,495 "
Private	2,720 "	5,640 "
Grand Total	44,419 kilom.	94,454 kilom.

CABLE COMPANIES.

After the telegraph comes the cable, but as far as regards Argentina, this country really had cable communications with the outer world before it had any telegraphs to speak of. The pioneer of submarine cables not only in Argentina but also in South America was the River Plate Telegraph Company, which was formed to work the concession granted to Messrs. John Proudfoot and Matthew Gray, of London, for a land and submarine line from Buenos Aires to Montevideo.

The concession was granted on December 10, 1864, with a monopoly for 15 years. The line was laid by Mr. John Oldham in the River Plate, in October, 1866, from Punta Lara, near La Plata, to Colonia, on the Uruguayan coast. This line was opened to the public on November 30, 1866. The first communication to Europe was established in August, 1874, *via* River Plate Company's system, to land line from Montevideo to the Brazilian land lines at Yaguaron to Rio Grande, thence by submarine cable *via* Pernambuco to Europe. In August, 1875, the coast cables from Rio Grande were extended to Montevideo and within recent years all the different sections have been duplicated from Lisbon to Buenos Aires.

In 1882, the *via* Galveston cables were extended to Chili, and this gave a second route for cablegrams to Europe, but it was not until 1892 that the Galveston Company took over the land lines and opened an office in Buenos Aires. With the advent of this company the virtual monopoly that had been held by the European Company *via* Brazil was broken and the cost of cabling, which was then about $5 gold a word, has now, by means of this competition, been reduced to $1.12 gold per word. In those days a message took about five hours between Buenos Aires and London, and this has now been reduced to 40 minutes and under. In 1894, the Pacific & European Cable Company extended its cables to Valparaiso and constructed land lines to Buenos Aires.

The fourth company is the Telegráfica-Telefónica, with cables between Buenos Aires and Montevideo. This is a local company with telegraph and telephonic communications between the two capitals, a distance of 315 kilometres.

The cost per word to London is $1.12 gold and for telephonic communications to Montevideo $1 gold for every five minutes. Conversation is limited to half an hour. The system is metallic circuit and the telephones used are of the Ericsson pattern.

TELEPHONES.

The introduction of the telephone for public service dates back to the year 1881, in May of which year the first exchange was opened in calle Florida, in the house known as La Minerva. This was put up by the Pan Telephone Company, and in the same year Mr. B. D. Manton obtained permission to work an exchange with Gower Bell instruments. The concern was known as the "Bolsa Telefónica de Buenos Aires."

That the telephone soon came into public favor can be gathered from the fact that in November, 1881, or say after six months' existence the company has 221 subscribers.

In 1883 the Pan-Telefónica joined up with the Cia. Americana de Boston and became the Unión Telefónica. In 1886 the opposition companies amalgamated, and were purchased by an English Company which to-day is known as the United River Plate Telephone Company. The two companies were also working in Rosario and these were also bought up by the London company.

In the year 1886 a co-operative company was started in Buenos Aires under the name of the Sociedad Co-operativa Telefónica. From the year 1883 to 1890, private companies were being established in all the leading towns throughout the country; some of these provincial exchanges are to-day of considerable importance, but the majority do not number more than 100 to 150 subscribers.

According to the census returns for 1895 there were 41 telephone companies working in the Republic, the subscription varying from $8 to $16 per month. Of these companies, 33 were Argentina and eight foreign. The capital was $10,918,-740 ($3 equals five francs); subscribers, 10,379; stations, 123; employees, 639.

Twenty-nine companies used the Bell instruments with Berliner, Black, Breguet and Gower Bell improvements, five use Berliner with Siemen's improvements, and those of Alden, Morse, Ericsson and Company. Ninety-two towns were connected up (not necessarily to each other).

The two companies working in Buenos Aires have to-day 10,511 subscribers.

The telephone system throughout the country is in the hands of private enterprise, and not under governmental or municipal control. Concessions are obtained by application to the various municipalities to run overhead wires. Although at the present time the companies come under no control, attempts are now being made by the post and telegraph department to obtain control over the telephone companies working in the city of Buenos Aires on the ground that as their lines run into the province of Buenos Aires they should therefore come under national supervision. The duty on telephone material is from 5 to 25 per cent *ad valorem*.

The service rendered by the companies in Buenos Aires can not be considered as of a very high standard, and this is principally due to the fact that the subscribers have outgrown the system, and the companies have not kept pace with the times, although it must now be said to

their credit that they are endeavoring to place their system on a more modern basis.

The cost of subscription in Buenos Aires is high, when compared with that charged, and the service given in other large cities of Europe and America.

The tariff for the city is as follows: Business houses $15 per month; private houses $10 per month; restaurants, hotels, etc., $25 per month.

In the suburbs the subscription for business and private houses, is, $12.50 per month for the whole year, or $15 for six months, Hotels paying $25.

The company makes no charge for lines up to 10 squares, say 1,200 yards, from the nearest office, but above this distance subscribers are charged with the cost of construction.

The employees are of both sexes, but the majority of the switchboard attendants are women, the average wage being from $60 to $70 per month.

A concession has lately been granted by the National Government for a telephone line between Buenos Aires and Rosario, a distance of 305 kilometres, which has been taken up and will be constructed by the Cia. Telegráfica-Telefónica del Rio de la Plata.

An additional charge is made for talking over the long-distance lines which amounts to 20 cents to La Plata and 50 cents to Mercedes and Chascomús.

The majority of the lines are galvanized iron, although some of the trunk lines are of copper. Several of the trunk lines are worked on the metallic circuit by means of translators or repeating coils, and these give very satisfactory results, besides enabling various combinations to be made.

All the subscribers are on the single circuit with earth return, but the Union River Plate Telephone Company, in Buenos Aires, is now installing a metallic circuit system with underground mains.

The telephone companies in the city of Buenos Aires have to pay the following taxes: Head office, $500 per annum; branch office, $50 per annum.

The municipal taxes are $2 to $4 per annum, according to district, and for underground work the following: Street boxes, $5 per year; pits, $15; cable laying, $100 per square and $5 per annum, besides various other taxes, for repairs to pavement, etc.

Considerable trouble has been experienced by the telephone companies throughout the country from the electric light and traction companies, and the method adopted has been to establish an earth circuit common to all subscribers. This has partially improved matters, but in Rosario, where the electric light company uses rectifiers, there seems to be no hope for improvement until underground mains are employed.

The total capital represented by telephone enterprises is $5,300,000 gold.

ELECTRIC LIGHT.

Early efforts in electric lighting in this country were rather spasmodic. The first in the field was the Edison Company, in the year about 1882, when Mr. J. Sassenburg, agent of Messrs. Fabri & Chauncy, the firm which financed Mr. Thomas A. Edison in the United States, took out the Edison patents for Argentina.

Before going further I might mention that one of the first two electric light stations constructed outside of New York was established at Santiago, Chili, but that greatly owing to the heavy running expenses and the impossibility to secure competent electrical engineers the company failed.

It was after the establishment of the Santiago company by Messrs. Fabri & Chauncy that their representative, Mr. Sassenburg, came to this country and took out the patents; he was shortly after followed by a Mr. McCarthy who brought an exhibition plant so as to revalidate the patents; it being one of the requirements of the Argentina patent law that everything for which patents were taken out must be shown in the country within a certain period. This plant was installed and the old Confitería del Gas had the honor of being the first building lighted by electricity in the city of Buenos Aires.

A similar installation was made at Fray Bentos, Uruguay, to revalidate the patents in that country. Mr. McCarthy then went to Rio for a similar object where he unfortunately died, thereby putting a stop for the time being to Edison work in the River Plate.

In 1882, Mr. W. R. Cassels, whose name is so well known in connection with electric lighting in this country, and who can fairly claim the honor of being the father, not only of electric light, but also of electric traction in Argentina, came to Buenos Aires as representative of the Brush Electric Company, of the United States, and he had the intention to try to obtain the concession for public lighting for the city of Buenos Aires. The municipality, however, would not grant a concession, there being no doubt that the reason for the refusal was the influence of the powerful gas companies then working in the city. Don Torcuato de Alvear, who was then mayor of the city, gave Mr. Cassels permission to carry out a series of experiments, and a Brush plant was established in the market, situated at the corner of Alsina and Perú, and for several months he lighted up Calle Florida as well as several shops. This installation, however, was not a success, and it did not find favor with the public, more especially the ladies who complained that it made them look too white.

There being no opening for electric light at that time in the city of Buenos Aires, the plant was shut down. About this time, however, it was resolved to transfer the capital of the province of Buenos Aires from the city of Buenos Aires and to build a new capital at La Plata, and Dr. Dardo Rocha, the founder of La Plata, invited Mr. Cassels, who had by that time been joined by his brother Frank, to carry out a series of experiments in the then embryo capital. These were a great success, and it was definitely resolved to light that city by electricity, and in the year 1886 the city of La Plata had the honor of being the owner of the first electric light central station and the first to adopt this system of lighting in the Argentina Republic.

Early in 1887 the Central Argentina Railway Company erected at their Rosario station a private plant, the first of its class in the country. In the year 1887 Mr. Rufino Varela, a very intelligent young Argentine, but without previous practical electrical knowledge, decided to take up the matter. Mr. Varela had previously been engaged in the construction of some of the railways and had acquired a fair knowledge of civil and mechanical engineering.

Before proceeding further I wish to place on record what can be done by perseverance; and those who know the struggles and trials that Mr. Varela has had to undergo since 1887 in the various electrical enterprises with which he has been connected up to the present day, will, I am sure, grant him that praise which is so rightly due to him. In every sense of the word Mr. Varela is a self-made man, and he can look back with pride to his early trials in 1887 and to his little 12-horse-power engine, which, to-day, has grown into that large power station situated at the corner of Paseo de Julio and Montevideo, which is owned by the Compania General de Electricidad, of the city of Buenos Aires, to whom Mr. Varela transferred his rights in 1898.

Returning again to the early history of electric lighting in this country, it is my intention to deal with the different cities separately, giving a description of the various power stations at work at the present time.

With respect to the city of Buenos Aires we have seen that the first experiments were made in the years 1882 and 1883; a lapse of four years then appears to have taken place, and it was not until the year 1887 that a permanent plant was erected in the city. This was done by Mr. Varela, who erected a small 12-horse-power engine and Gramme dynamo in the Calle San Martin in front of the Cathedral, the building to-day being occupied as printing works. The system was low-tension, with two-wire distributions and the output was about 100 incandescent lamps of 16 candle-power. In the same year Mr. C. V. Boisot came to Buenos Aires as representative of the Edison Company, and succeeded in forming a local company, besides carrying out an installation in the Colon Theatre and the Bristol Hotel at Mar del Plata, he also established the electric light at Adrogué.

In 1888 Calle Florida was lighted from Mr. Varela's station and from that date up to the present time this street has always received the same system of illumination. In this same year a small plant was also erected in San Fernando by Messrs. Varela and Cuneo. In 1889, Mr. Varela constructed the Palermo Park station on behalf of the municipality, and in the same year he installed the plant in the opera house and it is worthy of record that such was the confidence that Mr. Varela managed to inspire that the opera house is the only theatre in Buenos Aires that has never been illuminated by,

nor fitted up for, gas lighting; it should also be noted that the light has never failed in that theatre. This opera house plant consisted of four 50-horse-power engines, the total number of lights being 2,500; the engines, boilers and dynamos being installed in 45 days. The difficulties to be overcome were great, as in those days there were very few wiremen, and this installation was at that day the largest of its class in the whole of the South American continent.

In 1887, Mr. Cassels erected a Brush multiple series system of public lighting in the town of San Nicolás, which, however, proved a failure, and an alternating system was afterwards erected which also proved a failure. In 1889, the Edison Electric Light Company commenced work in Buenos Aires, using the three-wire system with underground mains. Their central station was in Calle Cuyo, which is to-day owned by the Primitiva Gas. This company was in difficulties before its materials arrived in the country and like many other concerns it went under.

The year 1889 saw a considerable spurt in electric lighting work in the country, as several of the up-country cities adopted it, these being Rosario, Cordoba, Tucumán, Santiago, etc. In 1890, the Government, through Mr. Varela, established a high-tension arc lighting plant at the Buenos Aires port works. From 1890 to 1893 very little progress was made on account of the crisis, but in the latter year the first high-tension alternating plant was established in Buenos Aires by Mr. Varela. In this same year on account of the destruction by fire, through defective gas installations, of two theatres in the city of Buenos Aires, the municipality decreed that all theatres must in future be illuminated by electric light, and to meet this decree, extra plant was laid down in the opera house station, and current was given to 12 theatres. Until the year 1896 Florida was the only street lighted by arc lamps, or, in fact, by any system of electric light, and in that year the municipality erected a small plant of its own for lighting the Plaza Mayo and Avenida de Mayo, the machinery for this station being the old plant that was laid down in 1889 at Palermo; after the street lighting was given over to the private companies, this plant has again been installed in Palermo.

In 1895 the Primitiva Gas Company bought up the old Edison plant in Calle Cuyo, which had been acquired by Mr. Carlos Bright, to whom belongs the honor of giving the first all-day and all-night service. In 1898 Mr. Varela sold out his interests to the Compañía General, and, at the same time, the municipality granted permission to an English and a German company to establish central stations in the city. It was also decreed that all mains were to be underground. The above gives a short history of the rise of electric lighting enterprise in Argentina, which, during the past two years, has made very rapid strides, as a number of provincial municipalities have adopted, or are adopting, the light. A short description of these stations will follow:

Before proceeding I think it is worthy of record of showing what could be done in the old days by mentioning that in 1890 Mr. Varela was requested to fit up a plant for Sr. Unzue's house, in front of the waterworks, at Palermo, consisting of four engines and dynamos and an installation of 28 arc and 315 incandescent lamps and a small shed for the machinery, and that the whole was done and at work six days after the order was received.

The following short history of the public lighting of the city of Buenos Aires is of interest.

The first record that we have of the introduction of public lighting in Buenos Aires, and, therefore, the first in the country, was during the vice-royalty of Juan José de Vertiz, who, in 1778, decreed that the streets be lighted during the dark hours of the night. The tax on the householders was two reales per month on every door to the street which was made daily use of. The next mention that is made of the lighting is in the archives of 1794, when it appears that the contractors did not keep the city lighted up to the mark, with the result that orders were given to the alcaldes to see that the contractor complied with his obligations. The first lighting was done by means of tallow candles, placed in old lanterns. After several years, oil lamps took the place of the candles, which, in their turn were substituted by gas in 1855, and, in 1888, some streets were first lighted by electricity. To-day the city of Buenos Aires is lighted by means of 702 arc, 13,445 gas and 8,307 kerosene lamps, at a cost of $120,000 per month.

The public arc lighting is done by three companies; two by direct current with two or more lamps across the outers, according to voltage, and the other by alternating current with a step-down transformer to each lamp, placed across the outer and middle wires of the system.

The following are the taxes that the electric light companies have to pay in the city of Buenos Aires, and they are, to say the least, exceedingly heavy:

National Government tax	$500 to $1,000 per year
Transformer pits	$15 per year
Street boxes	$5 per year
Boiler tax, from	$100 to $400 per boiler
Seal for same, each	$10
Opening of street to make house connection	$10 each time
For use of subsoil with mains	5% of year's gross revenue
Tool carts, each	$5 per year
Laying cables, per square	$100
Opening up of streets within first year of paving	$200 each time
Inspection of sidewalks after removal	50 cts. per 1 metre
Permission to construct transformer pits	$30
Permission to construct street boxes	$10

Users of electric motors have to pay from $15 to $45 per annum, according to size.

The municipality also fixes the maximum price per kilowatt that the companies may charge.

Material for public lighting and power stations is allowed into the country duty free, other material pays a duty of 25 per cent *ad valorem*.

In the year 1895 there were, according to the National census returns, 15 electric light stations in the country, with a capital of about $1,650,000 gold and employing 3,804 electric horse-power; to-day there are 36 stations, with an approximate capital of $9,000,000 gold and an output of 21,000 electric horse-power. Of the stations to-day, 26 are direct current, 8 alternating and 2 use both systems. Outside of the public stations, there are also all the private plants in the various industrial concerns throughout the country, but it has been absolutely impossible to obtain any data concerning these. Their number can not fall far short of 300 to 400.

With the exception of those in the city of Buenos Aires all the electric light mains are overhead.

There are in Buenos Aires, at the present time, four public companies, one private firm, three municipal and two government stations, supplying electric light for public and private lighting and the total length of underground mains is not far short of 1,200 kilometres. The following are the stations:

Primitiva Gas Company—This station, originally erected by the Edison Company, in 1889, in Calle Cuyo, was purchased by Mr. Bright, and then sold to the Primitiva Gas Company, a local company. This station is the only one in the centre of the city, and its construction is not yet finished, the machines are placed in an engine room which has been excavated and is several metres below the street level. It has to-day an output of slightly over 2,500 electric horse-power. The system of distribution is the three-wire. The pressure between the outers at the houses of the consumers is 220 volts. The plant consists of one McIntosh, Seymour & Company 650 horse-power triple-expansion engine, direct-coupled to two General Electric multipolar dynamos giving 800 amperes at 250 volts each. One Willans high-speed 850 horse-power triple-expansion engine coupled to two Siemens bipolar dynamos giving 1,000 amperes direct at 250 volts each. Two Willans high-speed 450 horse-power triple-expansion engines direct-coupled to one Siemens bipolar dynamo giving 1,000 amperes at 250 volts each. Two McIntosh, Seymour & Company's 250 horse-power compound engines, belt-driving four Edison dynamos giving 500 amperes at 125 volts each. Two balancers, R. R. Jackson & Company, 25 horse-power each. One booster, Parker Brothers, for charging accumulators. One battery of accumulators, 2,000 ampere-hours capacity.

Cia. General de Electricidad—This company bought up the stations belonging to Mr. Varela, the first of which was erected in 1887. This station has a capacity of slightly over 4,000 electric horse-power. The system is the monocyclic; the maximum volts, 3,450. The plant consists of four 500-kilowatt, 3,400-volt monocyclic alternators, each mounted on the shaft between the crank disks of a horizontal engine of the Edward P. Allis Company, of Milwaukee. There are also four tramway generators with a total output of 1,150 kilowatts and a new plant will shortly be laid down for further tramway extensions. This company provides current for the Buenos Aires & Belgrano Electric Tramways, and has contracted to supply power to the Argentina Electric Tramways, which is converting the horse system of the Anglo-Argentina Tramway Company.

(To be concluded.)

A Decision in the Selden Automobile Patent Suit.

Judge Coxe, of the United States Circuit Court for the southern district of New York, has handed down a decision in the case of the Electric Vehicle Company and George B. Selden against the Winton Motor Carriage Company, Percy Owen and A. W. Chamberlain. The case was tried in equity, on demurrer to bill. The decision of the court, which was in favor of the Electric Vehicle Company, is in full as follows:

The bill, in the usual form, is based upon letters patent No. 549,160, granted November 5, 1895, to George B. Selden for a road vehicle, the motor being a liquid hydrocarbon gas engine of the compression type. The application was filed May 8, 1879.

The demurrer, though divided under five separate heads, is based upon the broad proposition that the patent, on its face, is void for lack of patentability.

Stated generally the argument for the defendants is as follows: The specification concedes that all of the elements of the combinations of the claims were old; that steam engines were employed to propel road wagons, liquid fuel being used to generate steam; that gas engines were old and their use, as well as that of other motors, had been proposed for tram cars and similar vehicles. This being the admitted state of the art it is argued that it did not require an exercise of the inventive faculty to substitute a gas engine for a steam engine in a well known self-propelling vehicle.

It is insisted, further, that the claims do not cover combinations, but are for aggregations merely.

The law is very plain. A patent must not be held invalid upon demurrer unless its invalidity so clearly appears that no testimony can change the legal aspect of the case. If doubt exists the complainant is entitled to its benefit; if the faults pointed out by the defendant may, by any chance, be cured by proof; if, in short, there be a possibility that the complainant may succeed, the demurrer should be overruled. Am. Fibre Co. v. Buckskin Co., 72 Fed. Rep. 508.

It should be remembered that the invention, if there be one, was made very early in the history of "horseless carriages." The court will take judicial notice that prior to May, 1879, the art of propelling vehicles by motors, carried by the vehicle itself, was in its infancy. These carriages were unknown to the streets of New York, and few were seen on the streets of Paris. They were, without exception, crude and tentative machines. Selden must, therefore, have been among the earliest experimenters in the art. If the thousands of steam and electric "automobiles" which now are constantly perambulating the streets of every large city had been available as models the task of constructing a successful "gas-mobile" would have been less difficult. In other words, the fact that Selden's work was done over 21 years ago should not be lost sight of in estimating the value of his achievement. Upon the present record he must be regarded as the first to construct a road locomotive provided with a liquid hydrocarbon gas engine of the compression type so arranged as to leave the platform of the carriage unobstructed.

The drawings of the English patents referred to show locomotives designed to run upon rails and, therefore, presumably, upon levels or light grades.

This was not the problem which was solved by Selden. He has made, or it must, on demurrer, be assumed that he has made, a self-propelling vehicle which is capable of traveling on ordinary country roads, going up and down hill, and making long distances without replenishing its fuel receptacle. Surely, it required invention to construct such a machine.

But in order to test the proposition still further let it be assumed that steam carriages and electric carriages similar to those in common use to-day were known prior to 1879, and that gas motors had actually been used to propel, upon common roads, the heavy and clumsy structures shown in the drawings of the English patents.

This statement of the prior art assumes three most pregnant facts not found in the record, but, even so, how stands the case? It is fair to assert that, in no circumstances, could it involve invention to create the patented machine because similar machines had been propelled by electricity and steam, and machines, differing radically in structure and purpose, had been propelled by gas? Was there nothing more than the new application of an old device to a well known class of vehicles?

It is thought that the complainants are entitled to a more liberal interpretation of the patent than that contended for by the defendants.

The patentee's contribution to the art should not be considered from a narrow point of view; his work should not be examined through an inverted telescope; the horizon of invention should not be contracted to the periphery of a sixpence.

The patent described an ingenious and complicated machine operated by a type of engine never used before in road locomotives, employing with safety a highly volatile and dangerous fluid. The carriage of the patent is easily handled; it economizes space and may be managed by one possessing no expert knowledge.

It can not be maintained, upon the English specifications alone, that the construction of such a machine required no inventive skill. It is possible, if not probable, that a light road carriage equipped after the English plan would prove a lamentable failure.

The doctrine invoked by the defendants, that the transfer of an old device to a new use does not involve invention, if applied without qualification or exception, would destroy many of the most valuable patents. See Potts v. Creager, 155 U. S., 597.

At pages 606 and 607 the court discusses a large number of situations in which the rule is inapplicable and concludes with the following pertinent observation:

"Indeed, it often requires as acute a perception of the relation between cause and effect, and as much of the peculiar inventive genius which is characteristic of great inventors, to grasp the idea that a device used in one art may be made available in another, as would be necessary to create the device *de novo*."

The court is clearly of the opinion that the immense weight of authority sustains the proposition that this patent can not be held invalid on demurrer.

The court has refrained from discussing the subsidiary questions mooted on the briefs as they may appear in a totally different light after the proof is presented.

The demurrer is overruled, with costs. The defendants may answer in 20 days.

The Automobile Show at the Grand Central Palace, New York City.

This evening, Wednesday, November 14, the Automobile Show at the Grand Central Palace, in New York city, will be opened. Practically all of the exhibits of the recent show at Madison Square Garden will be again shown and with them a number of others that were crowded out for lack of space at that time. The arrangement of the Grand Central Palace Show will be different from that adopted in the earlier exhibition, and it is thought will be much larger and more complete than its predecessor. In the earlier show the principal exhibits were placed within the oval track, thereby making it difficult to observe vehicles in motion on the track. At the Grand Central Palace the track is the central feature, occupying the entire auditorium, and the exhibits are distributed around it, a wide aisle intervening. A clear view of the entire track circuit is obtainable from two commodious balconies in the auditorium and the space within the track itself is reserved for the exhibitions of expert handling of automobiles.

The track is made of double-plank flooring, smoothly planed and closely fitted, no nails having been used in its construction, but joints having been made with screws. This makes it as smooth and hard as a park boulevard. To enable visitors to be taken on and off the vehicles without delaying others in motion landing stages are provided at various points.

The show will continue for 10 days, being open every day from 10 A. M. to 11 P. M. A number of contests will be arranged and conducted under the direction of a committee of the manufacturers exhibiting. The hall occupies an entire city block and is elaborately decorated and illuminated for the occasion. Great credit is due to Mr. Marcus Nathan, the manager of this automobile exhibition, for the great energy he has displayed in collecting exhibits, and doubtless a full measure of success will reward his efforts.

Foreign Demand For American Copper.

Experts in the movements of the American metal market say that the present prominence of copper may be in great measure attributed to the heavy and persistent ordering of European markets, which, for the first nine months of this year has built up the enormous figures of more than 1,000,000 pounds a day of copper exported, thus breaking easily all former records of a similar nature. Had it not been for this heavy and steady demand for the metal the present good prices and strong tone to our markets could not have been obtained.

Producing and importing, as we do, about two and one-fifth times as much copper as we can possibly consume at home, the development and maintenance of a strong export market is an absolute necessity. This has been attained, with the result that 50 per cent or more of the metal goes abroad at good prices. Were it not for this foreign trade the accumulation of copper would be so rapid and heavy as to cause alarming shrinkages in values in the course of a very limited time — a few weeks at most. The amount of the present demand is singularly propitious inasmuch as the production of our mines is now greater than ever before, so that the aggregate production of the metal to-day is far in advance of any similar "fat year" in the history of the industry in this country. Besides our own heavy production, large imports of Chilian, Australian and Japanese copper have arrived at New York and Baltimore, besides copper ore from Spanish, African and South American sources.

The following tables, reckoned in pounds of fine copper, not only contain the figures of copper production and exports this year, but the imports as well, imported ore excepted, from which the approximate domestic consumption may be estimated:

1900.	U. S. Production.	U. S. Imports.
January	47,069,120	9,662,271
February	46,809 280	6,419,491
March	52,153,920	6,337.443
April	53,910,080	3,329,979
May	50,807,680	5,474,259
June	50,702,400	6,261,460
July	51,546,880	7,215,019
August	47,190,080	3,987,200
September	47,904,640	5,795,520
Total for 9 months	448,094,080	56,282,642

1900.	Production and Imports.	Exports.	Home Consumption.
January	56,731,391	31,438,400	25,292,991
February	53,228,271	28,557,760	24,671.011
March	57,491,363	45,181,520	12,359,843
April	59,240,059	28,586,880	30,653,179
May	56,281,939	31,353,280	24,928,659
June	56,963,860	37,130,240	19,833,620
July	58,762,799	26,064 640	32 698,159
August	51,177,280	31,048,640	20,128,640
September	53,500,160	23,352,000	30,147,160
Total, 9 months.	503,377,622	282,663,360	220,714,262

The exports of copper since January 1, to October 1, are 63.22 per cent of the domestic production, or 56.15 per cent of the production and imports during this period. Deducting the exports of copper from the production and the imports of the metal, and taking the balance as representing the domestic consumption, the latter, in that case, would show an average of about 24,521,473 pounds a month for the nine months.

L. B. Stillwell, Electrical Director of the New York Rapid Transit Subway.

Mr. L. B. Stillwell, formerly electrical director of the Niagara Falls Power Company, and at present in charge of the electrical installation of the Manhattan Railway Company, has been appointed electrical director of the Rapid Transit Subway Construction Company, of New York city.

L. B. Stillwell, Electrical Director of the New York Rapid Transit Subway.

Mr. Stillwell will have charge of all matters pertaining to the electrical equipment and construction of the Rapid Transit Railroad, and has already entered upon his duties. He has had a large and varied experience as an electrical engineer since his graduation from Lehigh University.

He has been electrical engineer and assistant manager of the Westinghouse Electric and Manufacturing Company, electrical director of the Niagara Falls Power Company for the last three years, completing the installation of the great plant at the falls and organizing the operating force and for the last two years he has been engaged as consulting electrical engineer in the work of equipping the "L" road of this city with electricity.

The appointment of Mr. Stillwell as electrical director of the Rapid Transit Railroad is a significant indication of the progress which has been made in the development of the Rapid Transit Subway.

ITEMS OF INTEREST.

A bond issue is said to be contemplated by the city of Greenville, Ala., for the purpose of installing a municipal electric light plant.

A recent explosion, which caused $10,000 worth of damage, occurred in Mattoon, Ill., completely wrecking the local electric light company's power house.

The Consolidated Street Railway Company, of Bay City, Michigan, is preparing to do a power and lighting business in addition to their traction lines, and a large force of men is at work stringing the wires.

An increase of $1,500,000 has been made to the capital stock of the City and Suburban Telegraph Association, of Cincinnati, Ohio; and the Citizens' Telephone Company, of Houston, Tex., has added $100,000 to its capital.

Surveys have been completed from the Waukesha, Wis., electric lines from that city through Delafield to Oconomowoc and the entire lake region in the Waukesha district. The work is to begin very shortly and will be carried as far as possible this winter.

Larchmont, N. Y., expects to have a trolley railway in the near future to replace the present horse system. The company has already instructed its employees in the operation of the trolley car, and as soon as grants are made, the electric line will be inaugurated.

The truant officers of Tacoma, Wash., have temporarily crippled the service of the local district messenger company by enforcing the law, and compelling boys to attend school. It is stated that the boys are replaced, for the time being, by girls, who will deliver telegrams, but who will not be allowed to run errands or attend to parcel delivery.

Automobilists of Boston, Mass., and nearby towns have combined, forming an association which will be known as the Massachusetts Automobile Club. A charter has been secured and the organization incorporated under Massachusetts laws. A suitable stable or house for sheltering and taking care of members' vehicles is to be bought in the near future.

An experiment made with a view to ascertain the possibility of trolley and other electric lines as freight carriers is now being made near Washington, D. C., by the Washington Traction & Electric Company, and it is thought that it will result favorably with both the traction company and the merchants and produce raisers in the vicinity of that city.

Death of Henry Villard.

Henry Villard, financier, journalist and promoter, died in his residence, "Thorwood," at Dobbs Ferry, N. Y., on November 12, in the early morning.

Born Heinrich Hilgard, in Speyer, Rhenish Bavaria, on April 11, 1835, he was descended from ancestors prominent in German legal and literary life, and whose names are yet esteemed there.

In 1849, the boy was attending the gymnasium in Zweibrücken, the family home for 10 years, when the outbreak of the Revolution caused his father to put him to school at the then fortified town of Phalsbourg, in Lorraine, where the future novelist Chatrian grounded him in the French language. A year later he passed to the university at Speyer; but in October, 1853, he broke off his studies, and, in a spirit of adventure set out for the United States, intending to join the colony of his cultivated relatives at Belleville, Ill. Interchange of letters with them had always been kept up, and Heinrich's curiosity about this country had been greatly excited. He was an only son, but in any case the step could hardly have been approved by his father, whose opposition was, in fact, such that the boy —resolved, if he could not make a name for himself, not to unmake his own—borrowed the kindred appellation of a French schoolmate at Phalsbourg, and became Henry Villard. Later, when he had made his name one of power, he wished to return to his real title, but the change would have involved so many complications that, on the advice of his friends and at the solicitations of his wife, who was the daughter of the great abolitionist, William Lloyd Garrison, he retained the name under which he had made his fortune and his fame. He began his career as a financier through the negotiation of American securities in Germany. Subsequently he interested himself in western railroads and was chosen president of the Oregon Railway and Navigation Company. He then formed a new company, which acquired the Northern Pacific and the Oregon Railway and Navigation Company. His mode of procedure was to buy the stock first and to form the new company afterward. His ever keen interest in inventions of great public utility early attracted him to the commercial development of electricity, and made him an ardent believer in the profitableness of it. He was one of the first to encourage Edison with pecuniary aid in those experiments which resulted in the incandescent lamp now in universal use. In 1890, he purchased from this inventor his electrical manufacturing interests, including the Edison Lamp Company, at Newark, N. J., and the Edison Machine Works, at Schenectady, N. Y., and from these organized the Edison General Electric Company, of which he became president, serving in that capacity for about two years. When the General Electric Company was organized in 1893, Mr. Villard retired from the active management of the Edison and the Thomson-Houston companies, from which the General Electric was formed, and since then he has been practically retired, taking little or no practical interest in the new concern beyond that of a stockholder. At the offices of the company on Monday he was spoken of in the highest terms, a sincere tribute being paid to his ability and the steadfast belief and faith he showed in so practical a manner in electrical development by putting Edison where he could obtain recognition from a somewhat skeptical world of commercial enterprise.

Generous and charitable almost to a fault, he gave many thousands to educational, charitable and historical institutions; in Germany his bequests include the endowment of the great Red Cross Hospital, at Munich, and several other important institutions.

Mr. Villard is survived by his wife, daughter and two sons.

OBITUARY.

DeWitt C. Bunnell, eldest son of the late Jesse H. Bunnell, and head of the Bunnell Telegraphic and Electrical Company, of New York city, died November 11, at his residence in New York city, of typhoid fever. Mr. Bunnell had not completed his 24th year. The funeral was held Tuesday evening, November 13.

Marcus Daly, known for years as the "Copper King," died after a long illness on November 12, at the Hotel Netherland, in New York city. Mr. Daly was a native of Ireland and came to this country when a small boy. His first employment was as an errand boy in Brooklyn. Going to California as a young man he was struck by the mining fever and worked as a prospector for several years but without much success. In Montana in 1880, he became interested in the development of the Anaconda copper mines. His interest in this property gradually increased until at the time of his death it was estimated at more than $20,000,000. Mr. Daly had great ability as an organizer and handler of men, and was in many ways a picturesque figure.

Lieutenant F. Jarvis Patten died suddenly at his home in New York city, on the night of November 12. The cause of his death is not accurately known. For some time past Lieutenant Patten had been in ill health and afflicted with almost total deafness due to an accident in which he was injured some years ago. He was born in Bath, Me., 48 years ago, and educated in that town and at the United States Military Academy at West Point, serving after his graduation as a lieutenant in the regular army. He was wounded in the battle of Wounded Knee and other Indian fights on the frontier, and shortly afterward left the army to pursue his electrical studies. Lieutenant Patten was the inventor of a system of multiplex telegraphy, and at the time of his death was the vice-president of the Columbia Carbide Company. He was a prolific inventor and author of numerous papers before scientific and other societies.

PERSONAL.

Mr. J. Franklin Stevens, president of the Keystone Electrical Instrument Company, Philadelphia, was a New York visitor for several days last week.

Mr. Luther Stieringer, electrical engineer for the Pan-American Exposition, at Buffalo, N. Y., has gone to Hot Springs, Va., for a season of recuperation.

Dr. Louis Duncan, the well known electrical engineer of New York city, has been spending a week in the West where he has some important engineering work in hand.

Mr. George F. Porter, manager for W. R. Brixey, recently returned from Cape Nome and St. Michaels, where he had been engaged for some weeks on cable work for the government.

Mr. Joseph H. Williamson, formerly business manager of the Manufacturers' Advertising Agency, of New York, has become business manager of the Viennot Advertising Agency, of Philadelphia, with a New York office at 127 Duane street.

Mr. Ray D. Lillibridge, who has charge of the publishing affairs of a number of well-known electrical manufacturers and who is rapidly increasing his fame as a "systematist," has taken a new and better office at 20 Broad street, New York city, where his growing business will be better served.

The wedding cards of Mr. Samuel M. Hamill, president of the Siemens & Halske Electric Company, and Miss Marie Woodward Baldwin are out. The cere-

mony will occur at Grace Church, Baltimore, Tuesday, November 27. The ELECTRICAL REVIEW extends its most cordial congratulations.

Mr. W. J. Johnston, whose name for many years has been associated with technical journalism, as the publisher and proprietor of the *Electrical World*, has purchased *The Mining and Metallurgical Journal*. The paper will hereafter be issued under his direct personal supervision and management, from its present offices in New York and Los Angeles, and he will devote to its conduct his entire time and attention.

Mr. James L. Taylor has been elected third vice-president of the Consolidated Railway Electric Lighting and Equipment Company, of New York city. He was lately general European agent of the Pennsylvania Railroad, with offices in London, and previously had served in prominent positions on the railway lines of the Plant and Southern Railway systems. Mr. Taylor is well known in this country as a railway man and was delegate to the international railway congresses in London and Paris. His election promises to be a valuable addition to the organization of the Consolidated Company.

An Australian Opinion.

Mr. L. J. B. Wall, of Splatt, Wall & Company, of Perth, West Australia, recently returned to his offices in that city after an extended trip through England and the United States. He is credited with the following remarks regarding electrical matters in this country: "America, of course, is the home of electricity. In some places you can travel hundreds of miles in electric tramcars. From 150 miles north of Boston to 100 miles past Washington—a distance of about 800 miles—there is a continuous electric service. The trams have regular stopping places, and on the outskirts of the centres of population they travel at a speed of up to 50 miles an hour. In New York the wires conveying the electricity run under the streets." Before closing the interview, Mr. Wall remarked that he had brought out the agencies for several electrical and engineering companies of New York and London, and had ordered the additional electric lighting plant for the Boulder City and the plants for Mount Morgans and the Westralia Mount Morgan mine. He says that Western Australia is well advertised in London, and speaks highly of its exhibits at the Paris Exhibition.

The "Perfect" Enclosed Arc Lamp.

H. J. Linder & Company, 123 Liberty street, New York city, are manufacturing an arc lamp which they call the "Perfect" lamp, shown in the accompanying illustration. The manufacturers claim that this lamp possesses the advantages of economy, cleanliness, length of life, steadiness of light, small consumption of current, ease of retrimming, positive and

THE "PERFECT" ENCLOSED ARC LAMP.

certain feed and adjustable resistance controlled from outside the case.

Kneeland Reflector Shades.

A reflecting shade manufactured by the Kneeland Reflector Company, 222 Friend street, Boston, Mass., is shown in the illustration herewith. It is designed for use on a desk and is made in five sizes, 5, 7, 8, 9, 12 and 15 inches in diameter, the first three being finished in silver or green bronze and green enamel; the two larger sizes are finished in silver bronze

A REFLECTING DESK SHADE.

only. This is but one of the many lines of shades manufactured by this firm.

Automobiles

A new automobile road record has been made recently between New York and Cleveland, Ohio, by Mr. Alexander Winton, who made the 800 miles in 38 hours 30 minutes, actual running time.

A new automobile transportation company has been incorporated at Dover, Del., with a capital of $500,000, by Williamsport, Pa., capital and Mr. W. M. Hope, of Dover. The company will be known as the Union Automobile Transportation Company.

Telephone and Telegraph

Among recent incorporations in Illinois is that of the Monmouth Telephone Company, which has been chartered for $25,000 by local capital.

An increase of the capital stock of the United States Telephone Company, of Cleveland, Ohio, has been made recently, bringing the figures up to $2,000,000.

The Erie Telephone system made a net gain of 2,644 subscribers in October. Total number connected October 31, 137,214; number waiting connection, 3,177.

Improvements which will necessitate an expenditure of $50,000 or more will be made soon by the Bell Telephone Company in extending their service in Wheeling, W. Va.

Permission has been granted the New York & New Jersey Telephone Company to construct and maintain underground conduits in Plainfield, N. J., and it is expected that construction work will begin in the near future.

A franchise has been granted by the Valparaiso, Ind., common council to the Northwestern Telephone Company, giving it permission to use the streets and alleys of that city for poles and wires, in connection with the exchange and long-distance services between Valparaiso and other cities in the state.

The instrument statement of the American Telephone and Telegraph Company for the month ended October 20 shows:

	1900	1899	1898	1897
Gross output.....	67,198	50,861	33,639	23,131
Returned.....	30,737	18,044	11,823	7,145
Net output.....	36,461	32,817	21,816	15,986
Since Dec. 20:				
Gross output.....	524,362	539,598	278,363	185,874
Returned	220,698	163,271	120,082	76,251
Net output.....	303,664	376,327	158,281	109,623
Total outstanding....	1,884,169	1 501,577	1,077,402	883,472

A contract has been awarded by the United States Government to a Weehawken, N. J., manufacturing concern, for about $10,000 worth of telephone instruments for Manila, P. I. In order to fulfill the conditions of the contract, the company has put 100 men at work, and increased the working hours from 13 to 14 hours per day. It is planned by the Government to extend the telephone system not only throughout Luzon, but to connect Manila with as many of the other islands as possible.

A STUDY OF CERTAIN SHADES AND GLOBES FOR ELECTRIC LIGHTS, AS USED IN INTERIOR ILLUMINATION.*

BY WILLIAM LINCOLN SMITH.

Two features which, perhaps more than all others, serve to distinguish our modern artificial sources of illumination from those of older date, are, first, the smallness of the flame or light-giving body, and, second, the high intrinsic brilliancy of the same.

The Welsbach incandescent mantle and the acetylene flame are examples of gas-using apparatus, and the electric arc and incandescent filament of apparatus perhaps more widely used.

On account of these distinguishing features of modern lights, it becomes imperative to use in connection with them, for purposes of general illumination (omitting, of course, such special purposes as lighthouse work, various kinds of signal lights, and in general, all cases where a concentrated, brilliant ray is desired), some form of shade or enclosing globe which shall cut down the intrinsic brilliancy, and, if possible, concentrate the softened light in those directions or upon those objects where illumination is particularly desired.

It is a fortunate fact for us in our attempts to produce satisfactory illuminations, that the eye does not depend upon the absolute illumination of bodies; but that the absolute illumination of a landscape or room may vary within very wide limits, and, provided the relative illumination of the several parts remains unchanged, the eye will still be satisfied.

Again, it is a fact, though apparently unknown to many, that for the majority of purposes, a well-distributed moderate illumination is far superior for results obtained, and comfort and ease of the eye, than a decidedly brighter and more concentrated illumination. The reason is, that in the first case the eye is able to work with a larger aperture and the muscles in a more easy state, while in the second case the aperture is stopped far down and the muscles more tense and strained.

Nevertheless, the average person is more prone to transgress rules of health and comfort in the matter of illumination than in many another less important matter. As a salesman of a large supply house said to me some time since in regard to a certain shade, "We know perfectly well that that is one of the best and most satisfactory patterns we handle, but you can't make the average buyer believe it."

The average person is not satisfied with a good, soft, well-distributed illumination; he wants something with more size to it, a big glare for his money. He would never dream of allowing direct sunlight to fall upon his desk, but he will deliberately hang a good-sized incandescent light over his work, about a foot in front of him and a foot above his head, so that every time he raises his eyes they meet that bright spot.

Again, he will work, or be made to work, at a desk thus lighted by a single lamp, a green paper or tin shade put upon it to concentrate the light downward, and the rest of the room in consequent gloom, so that every time he looks away from his work the eye passes from light to shade, and back again, with the resulting strain upon it, so that after a little while another person has to be fitted with glasses.

This remedy is, of course, simple, and there exists no excuse for neglecting it. If a bright light is needed localized upon a desk or table, this should be superposed upon a moderate general illumination of the room, so that the decided contrast of light and shade is prevented. Or, if only the single desk light is to be burned, it should be fitted with some type of shade which, while projecting the greater part of the light downward upon the work, will still allow a sufficient amount to escape to produce a mild illumination of the surroundings. In any case, the light should be so placed as to be out of the field of view of the worker under all ordinary conditions.

It is hardly too much to say that the ordinary person does not know enough to properly arrange his own lights—the average wireman certainly does not—and that the architect and interior decorator too frequently will not, because he still is carried away with the desire to use fixtures and light for decorative purposes, more or less in defiance of scientific considerations. This use for decoration of interiors is legitimate certainly, provided it is not allowed to mask the true purpose of the sources of light, so as to make them rather sources of torment than of light to the unfortunates who may be forced to sit near them, and who have mind and soul distracted from their proper occupations for the time being, in the vain attempt to avoid dazzle or glare and allow the eyes to take in surrounding objects in peace and comfort.

As a matter of fact, the source of light ought to be invisible, or else so toned down as to be unobtrusive, and its presence simply inferred from the general excellence of illumination produced by it; for it is a self-evident fact that we only desire to see the light source in the single case of signal lights, and in all other cases we desire to see an object or objects by the aid of the light source, for which purpose the source itself should be outside the field of view.

Since, in the vast majority of cases, it would be either exceedingly inconvenient or expensive to hide the source of light completely, it has become customary to leave it exposed (and frequently in the field of view), but to fit it with a shade of some kind, so as to render it more unobtrusive and more suitable for the purpose at hand.

Shades may be classified into:

1. Those which aim to be simply ornamental, and which, being nothing else, will not be considered further.

2. Those which aim to cut down the light and diffuse it more or less.

3. Those which aim not to diffuse the light, but simply to concentrate it in certain directions.

4. Those which aim to both diffuse the light and also to distribute it in certain directions.

There is an enormously large number of shades upon the market, the vast majority of which have no other reason for being than to satisfy the whims of their makers, and the individual idiosyncrasies of the hoped-for purchaser. How whimsical they are, and how little the particular pattern of any one has to recommend it, is shown by the recognized difficulty of replacing, a year or so after purchase, any one of a set which may have become broken.

A small minority remain on the market through a number of years, because they have become, as it were, standard patterns, and are simple, such as plain, frosted and opal globes of various tints.

A still smaller number remain because they, in a more or less satisfactory manner, do the work for which they were designed, and do it comparatively well and fairly efficiently, one, at least, remarkably efficiently.

The following series of tests were made upon a number of the leading types of shades and globes for electric lights, by no means exhaustive of available styles, but still, it is believed, fairly representative, and form part of a more extended study of illumination which it is hoped to continue the present Winter.

The results here given will be found to be based principally upon mean spherical candle-power. I am well aware that this quantity has been made too much of in the past, and that it is not always nor most frequently the best standard of comparison, since it is not the quantity with which we are most frequently and directly concerned. I think, however, that at the present stage of the investigation, it is the best standard of comparison, and almost the only one available for the purpose in hand. At a later stage, others will present themselves and prove to be more convenient and satisfactory.

The following types of shades were tested:

1. Holophane pendant, one-piece sphere, Cat. No. 3,550. 2. Holophane pendant, one-piece sphere, Cat. No. 3,551. 3. Holophane stalactite, Class A, Cat. No. 3,354. 4. Holophane stalactite, Class B, 5½″ by 8″, Cat. No. 3,250. 5. Holophane stalactite, Class B, 4″ by 6″, Cat. No. 3,150. 6. The same style of Holophane, but with old style of cutting. 7. Holophane upright one-piece sphere, Cat. No. 3,105.

* Extracts from a paper in the *Technology Quarterly and Proceedings of the Society of Arts.*

8. Holophane pendant tulip, 3½" by 5¼", Cat. No. 2,251. 9. Holophane pendant tulip, 4½" by 5¼", Cat. No. 2,250. 10. 9" by 3¼" stalactite prism. 11. 9" by 3¼" canary stalactite. 12. 9" by 3¼" opaline stalactite. 13. "M" prismatic tulip. 14. 7" McCreary shade. 15. 6" ball pendant, upper hemisphere opal and lower hemisphere clear glass, with a many-rayed star cut in the bottom of it. 16. A. E. G. 50-candle-power, 112-volt, spherical-bulb, coiled-filament lamp. Coil of filament in centre of bulb, and basal hemisphere of bulb silvered on the outside. 17. Same lamp, with silver minor removed. 18. 8" deep tin cone, white enamel inside. 19. 6" deep cone, fluted porcelain. 20. 6" flat cone, fluted porcelain. 21. 6" ground glass ball. 22. 6" prismatic glass ball. 23. 6" opal ball. 24. 6" opaline ball.

The first nine shades are made of the so-called Holophane glass, which aims at both diffusion and directive action on the rays of light given off by the enclosed lamp. It accomplishes its results by two systems of cutting, one on the inner and the other on the outer surface of the shade. That on the inner is a system of ribs, running vertically.

The outside system of cutting consists of parallel prisms, one above the other, covering the whole outer surface of the shade. Each circular prismatic ring has its angles determined by its position on the shade and the deflecting effect desired of the shade as a whole. Each prism has a compound surface, one part acting by refraction and the other by total reflection. The inside system produces diffusion, and the outside system produces the desired deflecting of the various rays, the shade itself being made of clear glass. This type of shade is thoroughly well worked out on accurate lines, is very efficient, and produces a most pleasing illumination, soft and powerful; the source of light appears to be a large, mildly-glowing surface of sparkling points, very unobtrusive, it being possible to see readily and comfortably past the light. The shade is also free from spectral bands of color, which occasionally appear with some other types.

Three lamps were chosen, all General Electric, rated at 112 volts, and respectively 16, 32 and 50 candle-power. These lamps were carefully tested unshaded, and then fitted with the various shades as desired. Four of the shades, however, as noted further on, were tested upon a Bryan and Marsh lamp, as the 16 candle-power General Electric was unfortunately broken. Measurements were made upon a 200-inch photometer bar very thoroughly screened, and all stray light was thus eliminated. Of course, we must realize that when the shaded lamps are upon the photometer the source of light is no longer a point, or even approximately one, and hence the law of inverse squares is no longer strictly true.

The primary standard used was a Hefner-Alteneck lamp, burning acetate of amyl, made by Krüss, numbered 796, and bearing the Reichsanstalt certificate No. 430. This is usually assumed to be equivalent, under proper working conditions, to .885 standard candles. I compared it against 12 standard candles, using a 100-inch bar and a Lummer-Brodhun screen, and obtained a mean value of .869 candles.

The secondary standard which was used throughout the tests was a special aged incandescent lamp run at 112 volts, and giving in the marked direction, as compared with the Hefner lamp, a value of

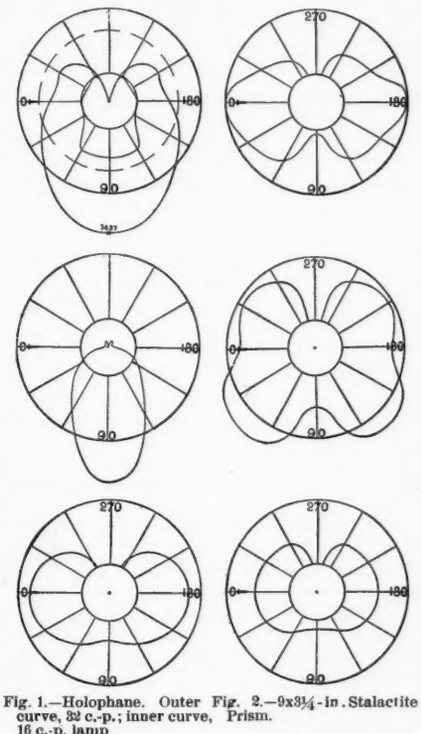


Fig. 1.—Holophane. Outer curve, 32 c.-p.; inner curve, 16 c.-p. lamp.
Fig. 2.—9x3¼-in. Stalactite Prism.
Fig. 3.—7-inch McCreary Shade.
Fig. 4.—Holophane Stalactite.
Fig. 5.—Ground Glass Ball.
Fig. 6.—6-in. Opal Globe.

FIGS. 1-6.—A STUDY OF ELECTRIC SHADES.

10.57 candle-power, this value being the mean of 12 tests.

These tests were made at about equal intervals throughout the course of the work and the mean value used in the calculations.

Voltage was measured on a Weston voltmeter, No. 4,915, which has been carefully kept and calibrated frequently; its error at 112 volts (the voltage used in all this work) was + 0.14 volt.

Current was measured on two Weston ammeters, No. 1856, reading to 1.0 ampere and with negligible error, the other, No. 384, reading to 5.0 amperes and having a zero error of + .05 ampere.

In the calibration of the secondary standard a Lummer-Brodhun screen was used, but throughout the rest of the work a Bunsen disk, which had in previous work proved very satisfactory, was made use of, as it was far more convenient and satisfactory for my purpose.

The absorption factors range from a minimum of 10 per cent to a maximum of 33.5 per cent, in the cases of the large Holophane stalactite (using the 50-candle-power lamp) and the McCreary shade, respectively. The watts per mean spherical candle-power vary from a minimum of 5.22 to a maximum of 7.41 in the cases of the prismatic glass ball and the McCreary shade, respectively.

The watts per maximum candle-power vary from a minimum of 1.30 to a maximum of 5.64 in the cases of the McCreary shade and the stalactite prism, respectively.

It is, however, manifestly unfair to make a direct comparison between a shade which, like the silvered minor A. E. G. lamp, aims simply to concentrate the light downward without diffusion, and one which, like the opal ball, aims simply to diffuse the light without changing its distribution materially; while, again, both these types should be separated from such shades as the Holophanes, which aim not only at redistribution, but at diffusion, and, moreover, at such thorough softening of the light as to render it possible to see objects comfortably, even when the light is directly in the field of view (as is perfectly possible with a 12-inch sphere containing a 100-candle-power light). Indeed, in one place recently fitted with these shades, there was a 16-inch sphere containing a 150-candle-power lamp surrounded by a circle of eight 8-inch spheres, each containing a 32-candle-power lamp, giving a maximum of 360-candle-power, allowing for absorption, concentrated in a space of about 50 square feet, and the lights nearly in the same plane. It was here found perfectly possible to view with comfort the detail of ornament directly behind this cluster.

The Holophanes, therefore, set themselves a more difficult problem than the great majority of shades tested, and one would hardly expect as great efficiency from them as from a pattern aiming at a less exalted mark. This, however, turns out contrary to expectation.

Another point to be considered is brought out by these tests as follows: If we take the Holophane, Class A, No. 3,354, and test it with a 32-candle lamp, we shall have an absorption of 14.6 per cent; while, if we test it with a 16-candle lamp we get an absorption of 12.2 per cent. Again, take the larger stalactite, No. 3,250. Testing with a 16-candle lamp at 112 volts, we find an absorption of 16.2 per cent. If we use this same lamp, and run it at 140 volts, thus getting a candle-power of (as it turned out) 37, we find the absorption has risen to 17.5 per cent, the distribution not being greatly changed. This, I think, is because of the higher refrangibility of the rays given out. But if we get this same candle-power by using a larger lamp, we get an absorption of but 10 per cent. Accordingly, as I have found this rule to hold in other cases as well as those here mentioned, it seems clear that for each size of Holophane shade there is a particular-sized lamp which will turn out to be best suited to that shade.

If, then, we tabulate the tests upon the Holophane type of shades, we shall have the following table, giving as a mean percentage of absorption 13.2 per cent:

	Number of shade.	Per cent absorption.	Efficiency in terms of watts per mean spherical candle-power.
1	3,551.	13.8%	86.3
2	3,354 (16 candle-power).	12.2%	89.3
3	3,354 (32 candle-power).	14.6%	85.6
4	3,250 (16 candle-power).	16.1%	84.1
5	3,250 (same lamp, run 30 volts high).	17.5%	77.0
6	3,250 (50 candle-power).	10.0%	90.2
7	3,150 (old style).	16.8%	83.4
8	3,150 (new style).	10.8%	89.4
9	3,105.	12.1%	87.8
10	2,250.	10.8%	89.4
11	2,251.	10.1%	89.3

The above value, however, includes two items which could be, with perfect justice, discarded; namely, Nos. 5 and 7, the former because no one would ever dream of running a lamp 30 volts high, and the latter because it represents an obsolete form which was tested only as a matter of historical interest. Discarding, then, these two values, the mean result remaining at 12.3 per cent. This, again, might, with good show of reason, be reduced by further omitting Nos. 3 and 4, since, as we have seen, if this type of shade is used under strictly the best conditions, the size of shade and lamp will be mutually adjusted. If this modification be made, we reach a final value of 11.4 per cent as the absorption. As, however, it is not probable that in many cases such an amount of care would be used, we will take both values into consideration. We shall find that, except for the satisfaction of being able to claim an additional 0.9 per cent for this type of shade, nothing is altered. The only shade which appears with a less absorption factor is the "m" prismatic tulip, with a value of 10.1 per cent. The two fluted porcelain cones are the only shades which approach the above values, having one an absorption of 12.4 per cent and the other an absorption of 12.8 per cent. These, however, are both simply reflectors, and make no claim to diffusion or softening of glare, while the "m" prismatic tulip is also in no sense a substitute for the Holophane, and is hardly more than a clear glass shade with ornamental cutting. Aside from these three no other shade comes within 10 per cent of the Holophanes, the nearest approach being that of the prismatic ball, with a value of 20.7 per cent. The McCreary shade stands at the other end of the list, its absorption being 33.5 per cent; it has close competitors, however, in the stalactite prism, the opal ball, and the tin cone, with absorptions of 30.8 per cent, 32.2 per cent and 28.1 per cent, respectively.

We may compare efficiencies in the line of watts per mean spherical candle-power, but since the various test lamps used do not have the same values for this quantity, we can not compare the shades directly. We may, however, determine for each shade the value of

$$\frac{\text{Watts per mean spherical candle-power (unshaded lamp)}}{\text{Watts per mean spherical candle-power (shaded lamp)}}$$

when the most efficient shade will, of course, be that in which this quantity most nearly approaches unity.

Applying this criterion, and figuring the Holophanes as before, we get values 86.6 per cent, 87.9 per cent and 88.8 per cent, respectively. Again, agreeing that the first value is not properly to be used, we find that it makes no difference which of the other two we see fit to use, which, of course, is to be expected as this is only another way of expressing the former results. The "m" prismatic tulip has a value of 89.3, and the two porcelain cones of 87.8 per cent and 87.0 per cent, respectively.

If we consider further the watts per maximum candle-power thrown in any direction, we find, of course, that the pure reflectors take first rank. The McCreary shade leads on the face of things, followed rather closely by the A. E. G. silvered lamp, and at a somewhat greater distance by the enamel tin cone. I question, however, whether this is correct, since the A. E. G. lamp was not really new, but had been burned, off and on, for some time, probably for100 or more hours, so that, although it furnished legitimate data for determining the effect of silvering a naked lamp of the same type, it is not probably correct to compare it with the other shades fitted with newer and more carefully-kept lamps.

From the results obtained so far in the investigation, it is my opinion that the Holophane type of shade is very greatly superior in general results to any other investigated.

Electric Railways

A new power station with a capacity of 600 horse-power for the Lowell & Nashua, N. H., Electric Railway, is to be built in Hudson, and ground has already been broken for the building.

Tenders are being asked for by the Electrical Construction Company, Limited, of London, Ontario, for the erection of its new factory, which will be a three story building, 40 by 100 feet.

A loss of about $1,000 was sustained by the Cleveland & Warren Railway Company at Gates Mills, Ohio. The car sheds together with a number of cars and other property were totally destroyed by fire.

A new power house will be erected by the Indianapolis, Ind., Street Railway Company in that city in the near future. It is estimated the building and equipment will necessitate an expenditure of about $500,000.

A trolley line will soon be built from Parkersburg, W. Va., to Marietta, Ohio. It is expected that the road will be completed within a year and will make all the towns within a radius of 12 miles tributary to Parkersburg.

Permission has been granted by the citizens of Bedford, Ohio, to the Northern Ohio Traction Company for a double track through the county provided the company charges flat five cent fares to Harvard street in Cleveland.

The Columbus & Springfield Electric Railway is now engaged in building its intersections with the Columbus, Ohio, Street Railway, which company expects to have its loop in the centre of the city completed in a very short time.

An electric railway is being projected from Zanesville to Marietta, Ohio, along the banks of the Muskingum River. Rights of way have been secured for almost the entire distance and power will be obtained from the falls of the river.

The contract for the construction of the electric line which will be built for the Uniontown & Monongahela Valley Electric Company into the Masontown coal field, has been awarded to the Tennis Construction Company of Philadelphia, Pa. The road will run from Uniontown to Masontown, and will be 20 miles in length.

Selma, Ala., will have an electric street railroad in operation by the first of February, and it is probable as soon as the line is completed that it will be extended to Summerfield, a small village nine miles distant, whose authorities have tendered the company rights of way and other possible inducements to get them to build the line.

A temporary power house for the Fox River Valley Electric Railway Company, is now being put up in Appleton, Wisconsin. This building and its equipment is intended to meet the demands of the company's traffic until the early Spring, when a permanent plant will be erected, which will have a considerably greater capacity than the present one.

A blanket mortgage, amounting to $2,250,000, has been placed with two banking firms in California by the Bay Counties Power Company. The reason for the mortgage is the desire of the company to obtain funds for improvements and extension of its lines to Oakland and also to furnish that city with light and power. It is believed that the power lines will be in operation within three months.

A horse car line is being promoted in Cebu, according to reports from Manila, with a capital of $200,000. It will connect the barrios in the vicinity of that important city and will be a horse line at first, but eventually will be converted to an electric system, the capital having been subscribed for the entire plant, and the officials of the road are only awaiting the formal permission of the authorities to begin the construction.

A High-Speed Engine of a Novel Type.

In the accompanying illustrations is shown a high-speed engine of a new type especially designed to meet the require-

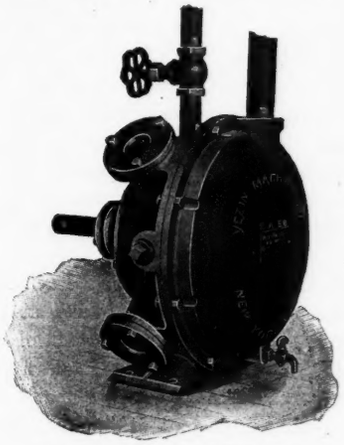


FIG. 1.—COMPLETE ENGINE.

ments of high-speed machinery such as dynamos, fans and centrifugal pumps, to which it is adapted to be coupled directly.

Fig. 1 gives an excellent idea of the general appearance of the engine, which is shown again in Fig. 2, direct-coupled to a small dynamo, and in Figs. 3 and 4 the mechanism is shown, the latter illustration showing the reciprocating parts.

Four cylinders are used, set 90 degrees apart in a solid frame, each cylinder being single acting and the reciprocating parts being balanced and lubricated in such a way that speeds, it is claimed, may be obtained that are impracticable in reciprocating engines. The pistons are connected together rigidly in pairs, each pair working together into a rectangular frame in which the crank-pin brasses travel. All of the valves, which are of the gridiron type, are actuated by a single cam. By this ingenious arrangement, it is stated that the maximum of strength is obtained with the minimum of material. A most interesting feature of the machine, however, is its method of lubrication. This is accomplished entirely by cylinder oil which is admitted with the steam supply. The waste oil, which passes out with the exhaust steam in the ordinary engine, is used in this machine for the lubrication of the crank-pin and other parts in the interior of the case. Steam is admitted to the cylinders in the usual manner and exhausts into the casing, where it surrounds the moving parts depositing upon them a portion of the water and oil discharged from the cylinders. In order for the steam to leave the casing it has to pass through T-shaped chambers (shown on the inside of the cover in Fig. 3) which form an effectual separator, thus leaving the exhaust steam fairly free of water and oil. This oil and water passes through the small stem or tube and into the end of the crank shaft, whence it passes through canals to the crank-pin, the centrifugal force throwing it outward to all the working parts and bearing surfaces. As the hollow pistons shown in Fig. 4 are exposed to the exhaust steam they are internally jacketed.

Exclusive of bolts and nuts the engine has only 14 parts and, as these are made interchangeable and no adjustments are required, it is claimed by the makers, the Vezin Machine Company, New York city, that a most inexperienced man can operate the machine or renew or replace parts, while, as he can make no adjustments, the machine is practically "fool-proof." The engine works with a fixed cut-off, using the throttling governor for electric light work. It is built in sizes of from three to 30 horse-power, the smallest size running at 1,500 revolutions per minute.

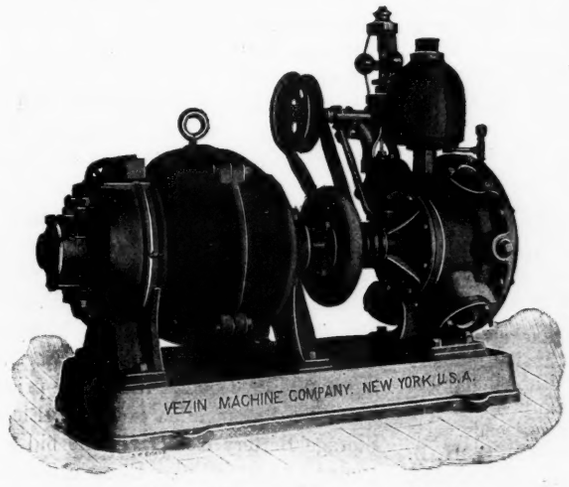


FIG. 2.—ENGINE DIRECT-COUPLED TO DYNAMO.

FIG. 3.—ENGINE WITH CASING COVER REMOVED.

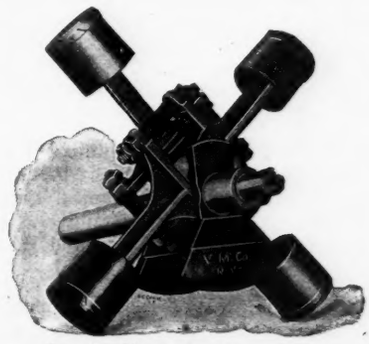


FIG. 4.—RECIPROCATING PARTS.

The Hungerford Electric and Manufacturing Company.

The Hungerford Electric and Manufacturing Company has been recently incorporated in West Virginia, with a capital stock of $1,500,000, divided into 15,000 shares of common stock. The incorporators are Ed. B. Merrill, Payson Dwight, J. W. Hayward, John S. Honeycomb, and A. W. Rose. This company owns the inventions and patents of Oliver T. Hungerford, important among which is an insulating compound for protecting electric wires and cables. This is said to be of very high quality and not the least important of its advantages is its low cost. It has been put to severe tests by some of the leading engineers and experts in the United States, and the company states that the consensus of opinion is that its compound is what manufacturers have been looking for for some time and which will permit the production of a high-grade insulated wire at a minimum cost. This company has been organized for the manufacture and sale of wires and cables insulated with the Hungerford compound, and in addition to this will supply other trades and the arts with the materials manufactured under Mr. Hungerford's patents. It is stated that Mr. Hungerford has spent 12 years in perfecting his discoveries and inventions, all of which, it is believed, will prove valuable to the trades to which they apply.

Corporation News

SHERIDAN, IND.—The Central Indiana Telephone Company was incorporated recently with a capital stock of $10,000.

ALBANY, OHIO—The Albany & Vales' Mills Telephone Company has recently been incorporated at $10,000 by local capital.

ANDERSON, IND. — The Lea-Hooven Manufacturing Company has been chartered for $15,000 by A. G. Lea, C. Hooven and C. Eastman.

HARVEY, ILL.—A charter has been granted to the Chicago Motor Vehicle Company, which has been incorporated at $1,000,000 by local capital.

EXETER, N. H.—Articles of incorporation have been granted to the Rockingham County Light and Power Company, which is capitalized at $350,000.

WARSAW, IND.—The Commercial Telephone Company, of Warsaw, has been chartered with a capital of $30,000. The incorporators and capital are local.

ST. THOMAS, ONT.—The St. Thomas Street Railway Company has increased its capital stock of $100,000 to $250,000 for the purpose of extending its system to Port Stanley.

NEW YORK CITY — The Lambert Schmidt Telephone Manufacturing Company, with headquarters at 93 Maple street, Weehawken, N. J., has been incorporated with a capital stock of $50,000.

NEW CASTLE, PA.—The New Castle & Sharon Street Railway Company has been incorporated, for $150,000, to build and operate an electric street railway between New Castle and Sharon, a distance of 20 miles.

TOLEDO, OHIO—The Ottawa County Telephone Company, of Oak Harbor, has been incorporated. The capital is $30,000; incorporators: H. Metzgar, E. D. Harkness, J. G. Steinkamp, T. Fuller and F. W. Gradolph.

HANNIBAL, MO.—The Hannibal Railway and Electric Company has been incorporated, with $100,000 capital stock, to construct a railway in Hannibal. E. D. Brewington, E. P. Bowman and H. J. Blathy are interested.

SALAMANCA, N. Y.—Local companies have been organized at Salamanca and Akron, N. Y., and will begin the erection of exchanges at both places at once. The company at Salamanca is capitalized at $5,000; that at Akron for $10,000.

JERSEY CITY, N. J.—The Exchange Telegraph Company has been incorporated to operate telephone and telegraph lines. The capital stock is $5,000,000, and the incorporators are A. Smedberg, L. B. Dailey, C. W. Perkins and others.

PORTLAND, ME.—The East Bangor & Portland Street Railway Company has been chartered at $12,000, and will lay its lines between Bangor and Portland. The road will be about 10 miles long, and construction will begin shortly.

IRONTON, OHIO—The Lawrence Telephone Company has been incorporated to construct and operate telephone lines. The capital stock is $24,000. W. B. Seaton, J. L. Anderson, H. Russell and others were the incorporators.

COLUMBUS, OHIO—Local capital is behind the Lima & Northwestern Railway Company, which has recently been incorporated with $10,000 capital stock, to construct or purchase a street railway line from Columbus to Weymouth.

VICKSBURG, MISS. — The Southern Light and Power Company has been organized, with $100,000 capital stock, to control electric light and power plants throughout the South. Chicago capital is said to be heavily interested in the new concern.

WEYAUWEGA, WIS.—A charter has been granted to the Wisconsin & Midland Railway Company, which has been capitalized at $25,000, to build an electric line from Berlin to New London *via* Weyauwega, and from Poysippi to Wautoma, by way of Pine River.

ST. PETERSBURG, RUSSIA—It is stated that the St. Petersburg municipal authorities will bid, on November 20, for the local franchise for the telephone systems of all Russian cities which have hitherto been operated by the State, as they will be sold at auction on that day.

TRENTON, N. J.—The Lackawanna & Wyoming Valley Rapid Transit Company has been incorporated with $2,850,000 capital stock. The company is authorized to equip and operate railroads. Its incorporators are F. H. Hansell, G. H. B. Martin and W. F. Idell, all of Camden, N. J.

INDIANAPOLIS, IND. — The Northern Indiana & Southern Michigan Telephone, Telegraph and Cable Company, of La-Grange, has been formed with $20,000 capital stock; directors: A. J. Hostetter, Rollin Ellison and Alice Ellison. The company will operate in Elkhart and adjoining counties.

LANCASTER, OHIO—The Lancaster Telephone Company was incorporated recently with $100,000 capital stock, by F. T. Pomeroy, O. R. Warner, A. E. Akins, M. J. Mandelbaum and J. O. Wilson, nearly all of whom are residents of Cleveland. The company will construct telephone lines in Lancaster and Fairfield County, and also a long-distance line with Cleveland and Lancaster as termini.

A Discerning Editor.

[*From the Chattanooga, Tenn., Daily News.*]

The ELECTRICAL REVIEW has the distinction of having the largest circulation and the most reliable firms advertising in it of any magazine of its kind published.

Wall Street and the Electrical Stock Market.

This week has been a memorable one in the stock market. The dealings reflected to an extent the sentiment of the public growing out of Tuesday's election, and although the business transacted was in large volume, well distributed and resulting in wide fluctuations in prices, still, considering this immense volume of business, the final changes were not so extensive as might have been expected. As is shown by the following quotations great advances in electrical securities are noticeable.

On the New York Stock Exchange, General Electric closed the week at 148 bid and 149 asked, showing a gain of 6½ points. Metropolitan Street Railway, of New York, closed at 167½ bid and 168 asked, indicating a gain of 9 points for the week. Third Avenue Railroad, of New York, closed at 112 bid and 113 asked, showing a gain of 4 points for the week. Brooklyn Rapid Transit closed at 78⅝ bid and 79 asked, showing a gain of 7⅝ points for the week. Manhattan Railway, of New York, closed at 107 bid and 107¼ asked, indicating a gain of 10¾ for the week.

On the Boston exchange, American Telephone and Telegraph closed the week at 152½ bid and 153½ asked, showing a gain of 5½ points. Erie Telephone was not quoted. New England Telephone closed at 126 bid and no asked price, showing a gain of 3 points in the bid price.

On the Philadelphia exchange, Electric Storage Battery closed with no bid price quoted and 81 asked. Electric Company of America closed at 10¼ bid and 10⅜ asked, indicating no change in either the bid price or the asked price. Union Traction closed the week at 34⅜ bid and 34½ asked, showing a gain of ⅛ point.

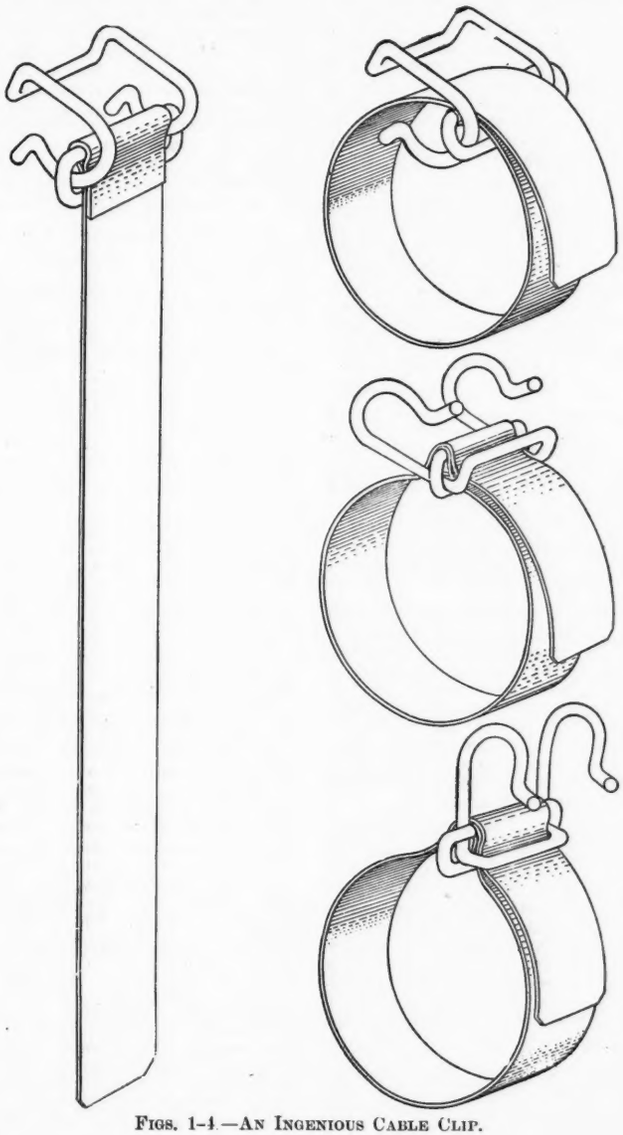
On the curb, or outside market, in New York, Electric Vehicle closed at 19 bid and 22 asked, showing a gain of 1 point for the week. Electric Boat closed at 20 bid and 22 asked, indicating a gain of 1 point for the week.

Wall street, November 10.

A report from the West states that the longest electric railroad in the world is to be built in the state of Montana, running from Billings to Great Falls, a distance of about 200 miles. It is thought that the Great Northern Railroad will take up the project and act as the chief promoter of the scheme, the idea of the road being to carry on traffic in coal, ores, and other heavy freight, being the first line to be operated by electricity for such purposes. The company has been incorporated with a capital of $4,000,000.

An Ingenious Cable Clip.

One of the most difficult problems in connection with the installation in place of aerial cables, such as are used so largely for telephone and telegraph work, is a proper method of supporting the comparatively weak cable and protecting it from mechanical injury both while it is being put up and after it is in place. There are various methods employed for this purpose, all of them alike in that the cable itself is hung from a strong supporting wire, generally a stranded steel wire cable. For the purpose of supporting cables a number of clips and fasteners have been devised and several methods more or less successful have been brought out. The accompanying illustration represents a cable clip or fastener for this purpose, which is claimed to have a number of decided advantages and to be free from the most frequent objection to such auxiliaries —the danger of puncturing or abraiding the soft lead sheath of the cable.



FIGS. 1-4.—AN INGENIOUS CABLE CLIP.

The device in question consists of two pieces of steel wire and a strap of sheet metal and is well shown in Fig. 1, which represents it ready for application to the cable. It will be noticed that there are no rivets, pins or buttons about the clip, which consists of only three pieces. The strap is long enough completely to encircle any ordinary size of cable, or even any ordinary joint, and the adjustment of the clip is affected entirely by hand, requiring no tools of any sort. The various stages of the application of the clip are shown in Figs. 2, 3 and 4. The metal strap is pulled tight around the cable before it is passed through the hanger, as shown in Fig. 2, and upon turning the hanger over the strap is bent down and locked in place as shown in Figs. 3 and 4. In this operation the lever action of the hanger takes up all the slack in the strap and binds it as tightly as may be around the cable.

On long stretches of cable it not infrequently happens, especially when the sag of the span is great or where one end of the stretch is lower than the other, that the clips slide down on the cable toward the lower point leaving the upper points unsupported. It is claimed by the makers of the clip here illustrated, the Chase-Shawmut Company, of Boston, that this can not occur with the "Boston" clip, because the strap can not slide on the cable after once being adjusted. It is also said that as the clip may be put on and adjusted accurately before the cable is put up, and as the hooks on the hangers will slide easily on the supporting wire, there is no necessity when they are used to make adjustments or put on clips by the use of ladders or hanging baskets.

Since the metallic strap of this clip contains no holes, and since no pins or other small parts are used in the clip, it is claimed that its mechanical strength is very great, the full strength of the steel wire and metallic strap being well utilized and the stresses evenly distributed. The instrument is so easy to adjust that considerable time is saved in this operation and the makers claim that this freedom from breakage and ease of application are high factors in the economy of its use. The clip is already in use by a large number of telephone companies who are well satisfied with its performance and durability. It is stated by the makers that the materials employed will not rust or deteriorate in use.

The Live Wire and the Jersey Citizen.

A Jerseyman had an experience recently with a live wire which he will hardly forget in a hurry. While crossing a street in Jersey City, over which run the feed wires of an electric company, one of them broke or was in some manner unfastened, and fell upon the wagon, spitting out some very lively sparks. The man, chancing to remember that his whip had a rubber handle, seized it, and after some spirited fencing with the heavily-charged wire, managed to toss it off into the street. In falling, its live end struck the horse's near hind leg, burning it quite painfully, and causing that worthy animal to gather himself together in sundry coltish leaps and plunges, and run away. He was at last pacified and brought under control, but the Jerseyman vowed thereafter to frequent only such thoroughfares as do not possess overhead wiring.

Industrial Notes

THE STRUCTURAL steel work of the Germantown Junction Station of the Pennsylvania Railroad will be furnished by the American Bridge Company.

THE NEW YORK & OHIO COMPANY, of Warren, Ohio, manufacturer of the Packard incandescent lamp and transformers, has just sent abroad its monthly art calendar.

THE WESTERN ELECTRIC COMPANY, Chicago, has secured a contract for one 125-kilowatt type "L" generator, to be installed in the Spitzer Building, Toledo, Ohio.

THE PROCTOR-RAYMOND MANUFACTURING COMPANY, Buffalo, N. Y., manufacturers of electric bells, are offering special prices, at this time, for high-grade bells and gongs of various types.

THE BURR MANUFACTURING COMPANY, 131 Viaduct, Cleveland, Ohio, manufactures an improved form of "come-along," which is claimed to be a positive wire stretcher of great value to linemen in stringing wire.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has in press a little book entitled "Skepticism" written especially for those who have doubts as to the Gutmann wattmeter being the best instrument of its kind on earth.

THE H. C. ROBERTS ELECTRICAL SUPPLY COMPANY, Philadelphia, has recently issued a circular illustrative and descriptive of Roberts weatherproof street hood, Roberts fixture block, and other new electrical specialties.

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY, of Cleveland, Ohio, after a thorough investigation, has awarded a contract to the Siegrist Lubricator Company, of St. Louis, Mo., to equip all of its machinery with the Siegrist automatic oiling system.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, Philadelphia, Pa., is mailing its "Just Happy" lithographed blotter, neatly presented in nine colors. This company is agent for the Adams-Bagnall arc lamp, and will gladly send pertinent descriptive matter upon request.

THE FIRST CALENDAR for the year 1901 to reach the ELECTRICAL REVIEW office is from the *Youth's Companion*, of Boston. It is a particularly attractive calendar and will undoubtedly be popular in homes as well as offices. Subscribers to this high-class publication receive the calendar, we believe, without charge.

THE NATIONAL MEASURED SERVICE COMPANY, 1039 Marquette Building, Chicago, is just placing on the market a new system of apparatus for the measurement of conversations in telephone service. The meter is a compact apparatus, and is claimed to fully accomplish all the requirements essential in this important work.

MR. FRED M. LOCKE, Victor, N. Y., during the early Spring, completed the construction and equipment of a new factory for the manufacture of the Locke high potential insulators. A recent visit to the factory showed that the demand for these insulators had so greatly increased that even the greatly enlarged facilities were taxed to the utmost.

ROSSITER, McGOVERN & COMPANY, New York city, are sending out a booklet of electrical machinery, of which they have a large and varied stock on hand. Particular attention is invited to the arc lamps they carry, the list including all the principal makes and styles. The booklet and folder will be sent on application to any one interested.

THE NORTH ELECTRIC COMPANY, Cleveland, Ohio, has recently concluded contracts with Colonel C. E. McCluer, general manager of the Richmond Telephone Company, Richmond, Va., and formerly general superintendent of the Southern Bell Telephone Company, for his toll system telephone apparatus, described in this issue of the ELECTRICAL REVIEW.

THE GUARANTEE ELECTRIC COMPANY, of Chicago, of which Mr. Charles E. Gregory is president, is well equipped for electrical repairing and is known as the "Dynamo Bargain House." Mr. Gregory is very widely known in the electrical field and is presenting many excellent electrical bargains in his extensive stock at 133 South Clinton street, Chicago.

AS AN INSTANCE of direct returns from advertising, the Burt Manufacturing Company, of Akron, Ohio, reports that it is crowded with orders as the result of illustrated notices of the Burt exhaust head. "Any article of merit," said Mr. Warden, manager of the company, "can be pushed successfully through judicious advertising in the trade journals, as we have demonstrated, to our own satisfaction, at least."

MR. WILLIAM ROCHE, 42 Vesey street, New York, manufacturer of the "New Standard" dry cell, reports having received an order for 500,000 cells for telephone use. This is perhaps the largest single dry-cell order ever placed. This firm is also making a new combination of dry cells for portable service, known as the "Autogas," which is particularly adaptable for automobile, launch, and other service where a compact ignition method is essential.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., is offering a free scholarship in mechanical, electrical, steam, locomotive, or marine engineering, including a course in mechanical drawing to those who are willing to answer inquiries regarding the value of the instruction received, recommend the school to their friends, and thus to a certain extent advertise the school and its methods. The course and methods are considered good.

THE CARPENTER ENCLOSED RESISTANCE COMPANY, New York, has been organized by Mr. C. E. Carpenter, who has been for several years well known in electrical engineering work, and latterly has been indentified with the Ward-Leonard Electric Company. The company's factory will be located at Park avenue and 130th street, and will be equipped with modern machinery for manufacturing rheostatic devices, and a complete line of electrical heating apparatus.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, has recently issued a number of bulletins describing alternating current motors and various special applications of these motors. One of the new types described in these bulletins is a back-geared motor which is suitable for belting to any slow-speed machinery and is particularly adapted for operating Mergenthaler or other type-setting machine. Copies of these bulletins will be sent free to any address on request.

HAROLD P. BROWN, New York, manufacturer of the Edison-Brown contact alloys, has just issued a pamphlet entitled "Microscopical Structure of Electrical Conductors," which is a reprint from London *Engineering*, and which discusses the loss of power encountered in passing electricity from one conductor to another through the various types of connections or bonds, as based on the experiments conducted by the Ecole d'Electricité under the auspices of the French Government at Paris.

THE CHASE-SHAWMUT COMPANY, Boston, announces the removal of its offices and factory from 161 Fort Hill Square to the Atlantic Building, 390-400 Atlantic avenue. In the new plant the company has largely increased facilities for caring for the growth in demand for the various electrical specialties which it produces. The company also makes this statement: "With our machine shop we have the finest equipped department for repairing motors and generators that can be found in the East."

THE AUTOMATIC TELEPHONE METER COMPANY, Orange, N. J., controls several patents bearing on telephone metering apparatus. The company is about to open a Boston office, and place its apparatus before the telephone field. The meters are so constructed as to be automatic in operation, and to register outgoing calls only, and then only in case of the completion of the telephone connection. Simultaneously, the meter will record the number of minutes consumed in the conversation, and the number of calls made during a given period.

I. P. FRINK reports the shipment to Paris, France, of reflectors for two more important lighting contracts in that city. This time it is the art establishment of Edw. Brandus, 16 rue de la Paix, and the store of Georges Petit, 12 rue Godot-de-Mauroy. The fixtures made for these contracts were cluster reflectors, and the famous Frink picture light that is used in the principal public and private art galleries in this country. The very successful Frink window reflector for stores is an adaptation of the picture light, and lights a window display on the same principle that paintings are best lighted.

THE PERU ELECTRIC MANUFACTURING COMPANY, Peru, Ind., has just issued a new catalogue, in handy size, descriptive and illustrative of the "Peru" standard electrical specialties. The volume is artistically bound in red, and contains about 200 pages, showing well-made illustrations, and much interesting data apropos of the "Peru" porcelain products. The catalogue is arranged in two sections, each section is divided into schedules, such as "Schedule A," "B" and "C", and each schedule refers to a particular class of goods. Among the standard specialties described, are various types of sockets, receptacles, attachment plugs, fuses, rosettes, branch circuit boards, knife switches, cutouts, cleats, ceiling buttons, porcelain insulators, mouth-pieces, bushings, tubes, and binding-posts. This company's New York office is in the St. Paul Building, and is now under the management of Mr. F. H. Schlesinger. The Chicago office is in the Monadnock Building, under the management of Mr. George S. Searing.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, of Chicago, Ill., has recently made shipments of a 600 multiple transfer switchboard and a 600 line combined cross-connecting and lighting arrester-board to the Shamokin Valley Telephone Company, of Shamokin, Pa., and 100 line Western express switchboards to the Home Telephone Company, Chillicothe, Ohio, and the Citizens' Telephone Company, Montevideo, Minn. This company is also building a 100-wire addition to a 500 multiple central energy switchboard lately furnished by it to the Schuylkill Telephone Company, of Pottsville, Pa. It has also closed contracts with the Staunton Telephone Company, Staunton, Ill., for a 100 Western express switchboard and 75 magnetos, and with Dr. J. H. Close, New Boston, Ill., for a 100 capacity switchboard; also for a 100 drop switchboard for the Columbia Telephone Company, of Columbia, Pa. Another contract has been closed to furnish the North Oklahoma Telephone Company with a 225 drop switchboard. Orders are strong for the new Western express No. 3, five-bar bridging telephones. These instruments are built especially for heavy toll-line work and for farmers' lines.